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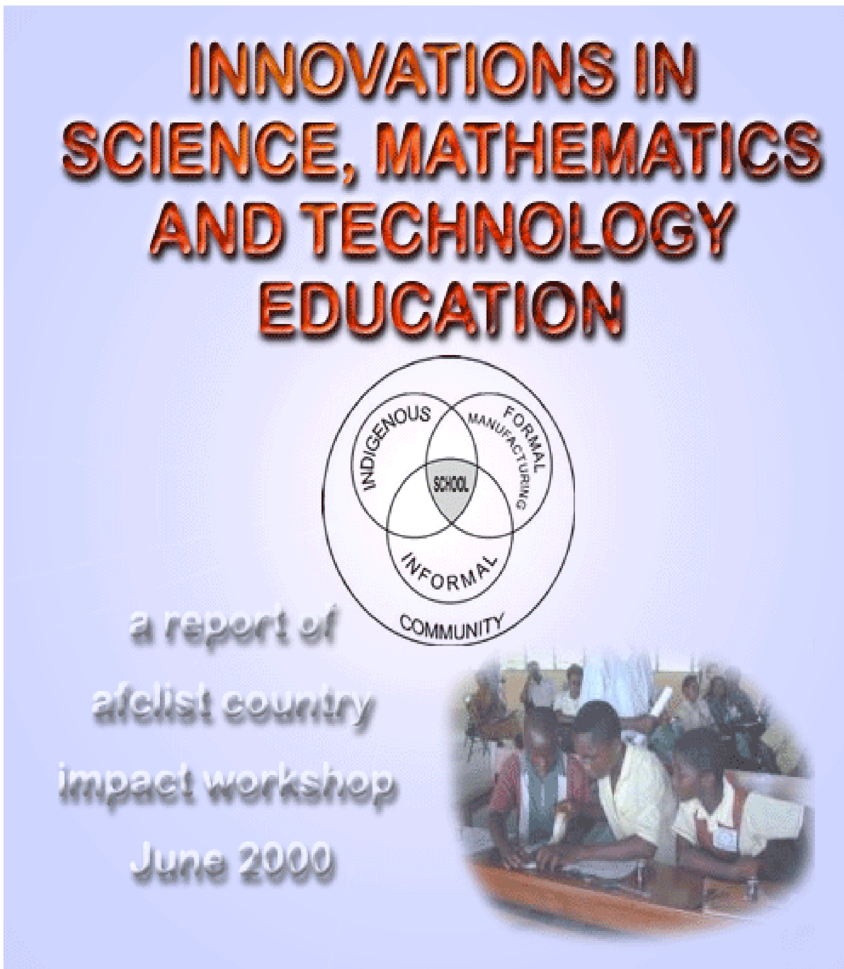

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Teachers' Views on the Role of Science Practical Activities in the Teaching of Science in Ghanaian Senior Secondary Schools

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Abstract

Ghana, like many other countries, has a strong tradition of doing practical work in senior secondary school science. In line with this tradition, the Senior Secondary School (SSS) science syllabuses issued by Curriculum Research and Development Division, and the West African Examination Council emphasise attainment of scientific knowledge, development of laboratory skills, and attitudes. This study surveyed the views of 50 science teachers' in 10 SSS in the Central Region of Ghana on the role science practical activities play in the teaching and learning of science using a questionnaire. Teachers' views on the role of science practical activities were mainly that of using them to support the teaching of scientific knowledge, and to some extent the development of attitudinal and laboratory skills. There was little emphasis on the use of science practical work to develop students' cognitive skills.

Introduction

The literature on science practical work shows that laboratories for the conduct of scientific research have existed at least since the seventeenth century. However, according to Jenkins (1998), the use of the science teaching laboratory, designed and equipped to teach science to students, is essentially a nineteenth-century phenomenon. Since the beginning of the 20th Century, there has been continuous increase in the supply of facilities and equipment suitable for practical science teaching in schools. This awareness of the importance of science became more prominent after the Russians launched their first satellite (Sputnik) in 1957. From that time, new American and English curricula spread to different parts of the world including Africa. By the late 1950s, some initiatives were taken which led to the large-scale curriculum reform movements in the 1960s in England and Wales. This was first funded by the Nuffield Foundation, and later by the Schools Council, set up in 1964 (Jenkins, 1998). In the 1960s, another cycle of science curriculum development began in England and Wales and concentration on laboratory work increased. According to Jenkins, in the Nuffield Projects, pupils were "as far as possible, to engage in investigative activities and, thereby gain vicarious experience of scientific

discovery" (p. 46). This project lent important support to the idea that had already been mooted that all science teaching should be laboratory-based.

In Africa prior to the 1950s, the textbook was the curriculum for science and hence what passed as the teaching of science was nothing more than information-giving by teachers and memorisation of the information by students (Collison & Aidoo-Taylor, 1990). The theoretical approach to teaching science was further encouraged by the emphasis it received in public examinations (Ajeyalemi, 1990). However, according to Collison and Aidoo-Taylor (1990), since the 1980s, attempts have been made in Africa as a whole, and Ghana in particular to use practical activities with the aim of providing opportunities for students to solve problems, learn enquiry processes and develop decision-making skills. The West African Examinations Council (WAEC) from 1998 to 2002 for example, emphasizes the acquisition of practical skills in biology, physics and chemistry as follows:

Biology

(a) acquisition of adequate laboratory and field skills in order to carry out and evaluate experiments and projects in biology;

(b) acquisition of the necessary scientific skills for example, observing, classifying and interpreting biological data.

Physics

(a) carry out experimental procedures using apparatus;

(b) develop abilities, attitudes and skills that encourage efficient and safe practice;

(c) make and record observations, measurements and estimates with due regard to precision, accuracy and units.

Chemistry

(a) enable students to develop laboratory skills, including an awareness of hazards in the laboratory and the safety measures required to prevent them;

(b) enable students to appreciate the scientific method which involves experimentation, accurate observation, recording, deduction and interpretation of scientific data

Hence the examination in each science subject (physics, chemistry and biology) consists of a theory paper and a practical paper. The practical paper is based on the content of the particular science subject. This according to Collison and Aidoo-Taylor (1990) is "intended to determine how well the candidates understand the nature of scientific investigation and the use of apparatus in a controlled experiment to determine an answer to a question" (p.17). According to Woolnough (1998) one way of looking at science practical activities is to categorize them broadly into those related to developing practical skills and attitudes; and those related to discovering or elucidating theory. The latter makes use of structured experiments linked to theory. Those who argue in favour of practical activities are however, divided on its aims and how it should

be organized so as to help students. They differ greatly in what skills are important and how they can be achieved. Some rank the aims related to practical skills more highly than those related to developing theory, and vice versa. In two major research exercises in the 1960s and 1970s reported by Millar (1998), teachers were asked to rank in order of importance lists of possible aims of practical work. Two of the main groups of aims ranked very high by teachers were those, which concern the role of practical work in supporting the teaching of scientific knowledge, and in teaching the processes of scientific enquiry. As noted by Millar (1998), "an investigative or enquiry approach encourages children to be more independent and self-reliant, to think of themselves as able to pose their own questions about the physical world and to find answers to them through their own efforts" (p. 17). It seems that much of what is said about practical work stems from this view about the use of the enquiry approach in the teaching of science. In reality, Millar (1998) felt that what practical work does is simply to reproduce a phenomenon, which has already been established (Millar, 1998). However, as noted by Hacking (1983), repeating what has been done serves two purposes for the teaching and learning of science. The first is that it shows a phenomenon can be reliably reproduced so that students could learn at first hand from the phenomenon instead of it being described to them, and they trying to visualise it. Secondly, since phenomenon is not easy to reproduce, the successful outcome of a practical activity is evidence that students have carried out the activity correctly, and with sufficient care and skill. Students are able to learn new ideas by being shown examples of them, rather than being given formal definitions, or other verbal accounts. As pointed out by Millar (1998), "when we get pupils to investigate the relationship between force and acceleration for a trolley, for instance, we are showing what the scientific ideas of 'force' and of 'acceleration' mean, by giving concrete examples of them" (p. 29). Essentially then, according to Millar (1998) whatever teachers may say about why they conduct practical work, the real purposes of practical work done in schools is to try to

> encourage students to make links between things they can see and handle, and ideas they may entertain which might account for their observation ... Practical work that is intended to support the teaching and learning of scientific knowledge has to be understood, and judged, as a communicating strategy, as a means of augmenting what can be achieved by word, picture and gesture (p. 29, 30).

Science practical work may therefore involve illustrations of a phenomenon, providing experiences or getting a feel for phenomenon by students, exercises or routines for students to follow, developing a particular skill, or becoming used to a piece of equipment or instrument.

Other surveys conducted over the past thirty years into reasons why teachers do practical work and the type of practical activities they do are reported by Woolnough (1998). According to him, teachers ranked those aims related to developing practical skills and attitudes most highly and those related to discovering or elucidating theory much lower. Yet Woolnough has observed that the type of practical work teachers consistently say that they do most frequently are structured experiments linked to theory (practical work to elucidate theory). Given the emphasis science syllabuses place on practical work in Ghana it is of

interest to find out Ghanaian science teachers views on the role science practical activities play in the teaching of learning of science.

Purpose of the study

In Ghana, like many other countries, there is a strong tradition of doing practical work in school science. This is because practical work is emphasised by the CRDD and WAEC science syllabuses and are examined externally by the WAEC. The key aims of the syllabuses are essentially the attainment of scientific knowledge, and the development of practical skills and attitudes.

It is widely acknowledged that for many students, scientific concepts may be abstract and difficult to grasp, hence teachers use different methods including practical activities to improve student understanding of such concepts. Practical work is considered to be effective as it allows students to change the abstract to the concrete, thus helping in the internalisation and understanding of concepts (Arce and Betancourt, 1997). There is however, a growing body of evidence indicating that despite this emphasis on practical work, much school science teaching is unsuccessful in giving students an understanding of the ideas of science and development of some scientific skills (Clarkson and Wright, 1992; Hodson, 1992). It is in the context of these findings that this study explored science teachers' views on the role science practical work plays in the teaching and learning of science in the Ghanaian context.

Subjects

The Central Region had 49 SSS, with 18 of them offering all three elective science subjects during the time of this study. In the 10 schools, where this study was conducted, all elective science teachers at post at the time of the study formed the subjects of the study. There were 60 science teachers available to respond to the questionnaires, out of which 50 questionnaires were completed and returned.

Instrument

The instrument used for the study was "Questionnaire on the Role of Science Practical Work". The questionnaire was designed after small-scale investigations of science practical lessons in some SSS. Discussions with science teachers and those acquainted with practical work at the SSS level also informed the design of the instrument. The questionnaire was validated by the researchers and other science educators at the University of Cape Coast. The draft questionnaire was pre-tested in two schools in the Central Region of Ghana.

Procedure

The questionnaire was administered to science teachers with the assistance of the Heads of Science Departments in the various schools. As much as possible, all questionnaires administered to science teachers were collected by the third day. Non responses were followed up thrice before attempts to retrieve the completed questionnaires were abandoned. This procedure resulted in a return rate of 83%.

Results and Discussion

The spectrum of views expressed by teachers on the role of practical work can be categorized into three. They are as follows: Science practical activities

(a) help students understand the concepts or theoretical aspects better and this aids teaching and appreciation of science;
(b) enable students to develop practical skills, collect, record and analyse data;
(c) enable students to verify facts and principles that are taught in class.

These views expressed by science teachers are in agreement with the aims of practical work contained in CRDD and WAEC science syllabuses.

However, when science teachers were asked to rank nine reasons for organising practical work, Table 1 shows that they ranked low, reasons, which were related to helping students to find facts and arriving at new principles, seeking for problems, and finding ways to solve them.

Table 1 Teachers' ranking of reasons for organising science practical activities

Reasons	Rank
To use science practical to clarify theory	High
To verify facts and principles already taught	Medium
To arouse and maintain interest in science	Medium
For students to develop specific manipulative skills	Medium
To encourage accurate observation	Medium
For finding facts and arriving at new principles	Low
To satisfy the science syllabus and WAEC examination requirements	Low
To enable students pass their final examination	Low
To practice looking for problems and seeking ways to solve them	Low

This confirms similar findings by other researchers elsewhere (Kerr, Thompson, Beatty & Woolnough as cited in Woolnough, 1998). Teachers also ranked low, reasons related to satisfying WAEC examination requirements, and helping students pass science practical examinations. These rankings were in agreement with views expressed by teachers in open-ended questions on the same issue. Reasons related to using practical work to clarify theory taught in class were ranked high by teachers, whilst those related to verification of facts and acquisition of manipulative skills were ranked medium. It must be noted that reasons for organizing practical work ranked high or medium by teachers are in line with the objectives of the CRDD and WAEC science syllabuses. Table 1, therefore portrays teachers' views on the role of science practical work as essentially that of helping students understand theory or content taught in science classes. This is supported by the results shown in Table 2. The table shows that generally, teachers organised practical activities to verify theory more often than not (96.0%). The majority of teachers (80.0%) with a mean of

3.04, indicated they always (30.0%) or very often (50.0%) conducted practical activities to achieve such a purpose.

The mean scores also indicate that teachers more often tended to conduct practical activities with the intention of developing laboratory skills (2.82) followed by developing scientific attitudes (2.58).
This means that about half of the science practical activities conducted by teachers were geared towards the development of scientific attitudes. The table however, shows a very low mean of 1.42 with 60.0% of the teachers indicting that they rarely or never allowed students to design and perform their own experiments. This however, is one of the objectives for conducting science practical activities as stated in the science syllabuses.

Table 2 **Mean scores and percentage responses in each category for each item (N=50)**

Type of science practical	Always	Very Often	Often	Rarely/Never	Mean
Practical to verify theory already taught in class	30.0	50.0	16.0	4.0	3.04
Practical designed to help students develop laboratory skills	20.0	44.0	32.0	4.0	2.82
Practical designed to help students develop scientific attitudes	12.0	42.0	36.0	10.0	2.58
Project work designed by students based on a problem of their choice	0	2.0	38.0	60.0	1.42

The lack of emphasis on the design and performance of experiments by students means that students have very little opportunity to identify their own problems, play a role in the design of appropriate experiments, as well as collect and interpret data themselves. Therefore, if students rarely pursue such activities, it would be difficult for them to develop cognitive skills associated with problem solving (Arce and Betancourt, 1997). Studies by Hannon (1994) and Arce and Betancourt (1997) have shown that when students are allowed to design their own experiments, they become motivated, curious, enthusiastic and confident. According to them, students find practical work challenging and rewarding as a result of this. Also Hodson (1990) acknowledges the fact that if students are allowed to pursue their own investigations in their own way through practical work, it can result in higher motivational power. It is therefore disappointing that majority of teachers stated that they did not allow their students to design and try experiments on their own. In assigning reasons for this, some teachers mentioned lack of equipment, large class sizes, and syllabuses overloaded with content. Others stated that their aim of conducting practical work was to cover the activities suggested in the WAEC syllabuses and that there was no time and room for individual adventurism. Apart from these, the problem of time constraint was the most cited reason by teachers for not

allowing individual students the liberty to design and perform their own experiments. According to those who gave this reason, there was so much work to do in completing the science syllabuses that students would not have the time to design and carry out their own experiments. Some teachers also felt that it would not serve any purpose for students to design their own experiments and carry them out, and pointed to the final WAEC science practical examination, which they said did not ask candidates to design their own experiments. Others thought it was not feasible for each of the over 50 science students in their class to design experiments and carry them out since as one of them put it “there will be confusion in the laboratory”. Most teachers pointed out that designing and performing experiments by students could only be done if there were fewer students as teachers need to supervise them. Even the 38.0% of teachers who indicated that they allowed their students to carry out individual investigations stated that students did so for science exhibitions during speech and prize-giving days in their schools. Only two teachers gave reasons related to encouraging students to be innovative and creative. Teachers therefore did not emphasise some of the objectives for conducting science practical activities as contained in the WAEC and CRDD syllabuses

Teachers were also asked to rank 10 practical skills students could develop during science practical work in order of importance. Three out of the 10 skills were related to development of attitudes, two directly related to laboratory skills, and the rest to cognitive skills. Table 3 presents the results of teachers’ ranking. It can be seen from the table that teachers ranked high or medium all the attitudinal and laboratory skills but ranked low, cognitive skills.

Table 3 Teachers’ ranking of practical skills in terms of importance

Practical skills	Rank
Observing	High
Manipulative	Medium
Initiative	Medium/High
Objectivity	Medium
Integrity	Medium
Problem formulation	Medium/High
Experimental design	Medium/Low
Predicting	Low
Drawing conclusions	Low
Hypothesizing	Low

This means that general scientific skills such as predicting, drawing conclusions and hypothesizing, which are related to the development of cognitive skills but which are not necessarily laboratory based were all ranked low. This is not surprising as the final WAEC practical examination has very little if anything at all to do with the development of the general scientific skills listed. However, general scientific skills which teachers ranked low (predicting,

drawing conclusions and hypothesizing) are rather those skills that can lead to the development of understanding of the concepts and procedures involved in science which students need to acquire (Arce and Betancourt, 1997).

Barton (1998) has observed that "too often the time and effort expended in collecting and processing the data tend to squeeze out activities related to analysis and interpretation of data" (p. 238). This seems to be the case, judging from teachers' responses. However, without analysis and interpretation, and drawing of conclusions, it would be difficult to link students' practical experiences with abstract concepts. However, helping students to make this link is an important process, and one, which should form one of the core activities during science practical periods. The study however, shows that science teachers saw this as less important compared to other skills.

Conclusion

Evidence from the study suggests that teachers' views of the role of science practical activities were dominated by the desire to help students understand theory and to a lesser extent, the development of laboratory and attitudinal skills. Teachers thus ranked the aims of practical work related to clarifying theory more highly than those related to developing practical skills. It seems this role of science practical work, has taken the centre stage in the teaching and learning of science, and has become the main reasons, though not exclusively, for conducting practical activities in schools. Ironically, Barton (1998) states that "many of the criticisms levelled against practical work focus on difficulties related to teaching 'theory' through practical work" (p. 238). In spite of the criticisms stated by Barton, it is contended that students' trying to find out information by themselves through practical work is a useful exercise, regardless of whether or not that knowledge is already known (Hacking, 1983). Practical skills such as manipulation of apparatus and observation even though ranked medium by teachers are not complete in themselves as they only constitute the first hand experience phase of science practical work. This should be followed by analysis and interpretation of the data collected, which were ranked low by teachers.

The findings of this study give support to the growing body of evidence that even though there is emphasis on practical work in the teaching and learning of science by the CRDD and WAEC science syllabuses, the conduct of science practical activities in the schools studied were more skewed towards the understanding of science content taught in the classroom than the development of scientific attitudes and the spectrum of scientific skills as envisaged by the science syllabuses (Clarkson and Wright, 1992; Hodson, 1992). Teachers' lack of emphasis on the development of cognitive skills may stem from the fact that these skills are not examined by WAEC. This tends to lend credence to the fact that teachers have the WAEC practical examination in mind when they organise science practical activities for students, even though they rated low reasons for conducting science practical activities related to satisfying WAEC practical examinations.

Recommendation

It is important for science teachers to conduct practical activities in line with the objectives of the WAEC and CRDD syllabuses and for the WAEC to examine all aspects of the objectives for asking teachers to conduct practical activities in school. This will make science teachers play equal attention to the development of cognitive, attitudinal and laboratory skills when they organise science practical activities.

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Science for Development: Failure in Ghana

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Abstract

The deplorable situation in almost all Third World countries with respect to diseases, poverty, housing and sanitation has prompted governments in these countries to look to science and technology as the panacea to their problems. Their belief rests on the evidence that science is an integral part of modern western society and that the levels of utilization of technology are directly related to their scientific progress. Science and science education are therefore considered to be the vehicles to uplift the Third World countries from their deplorable living conditions. Various strategies have been advanced and introduced by concerned international organizations including UNESCO. The 'Science For Development' model has been highlighted and practiced since the 1960s.Unfortunately realistic results have not been fort-coming. The factors for the seemingly intractable failures of the 'Science for Development' model have been identified in this paper .Among these is the fact that cultural perspectives have been ignored in the implementation of the imported model which is based on western worldview. The recommended constructivist approach to teaching and learning is also based on western worldview. The Ghanaian worldview has been discussed and recommendations made as to how to incorporate this worldview into the teaching and learning of science.

Introduction

In all the developing countries of the Third World, particularly Africa, signs of extreme poverty, poor sanitation, lack of safe potable water, diseases, poor housing, poor health services, high infant mortalities and low life expectancy are very visible. Many governments of the industrialized countries, international NGOs and agencies of the United Nations have expressed concerns for these deplorable situations, which are mostly preventable. Unfortunately the governments of these developing countries are incapable of solving or alleviating the problems. Therefore offer of any assistance from any quarter is most welcome to them. Rarely do they the recipient governments question the motives for the offers, the appropriateness of the interventions and the implications for accepting the offers.

The visible signs of economic and social developments in the western industrialized countries are very attractive and appealing to the developing countries. Of late, quite high on the agenda for fast track development in the developing countries is the notion that only scientific knowledge and exogenous technologies can provide the panacea for their problems. Hitchhiking on to the

fast lane of the current information technology through the Internet is most desirable.

We are here referring to citizens of the developing countries, the majority of whom are illiterate in science and technology without any access to good potable water or to electricity or to good housing but whose government are bent on importing western technologies and lifestyles. These government officials have been trained in the western industrialized countries and have exogenous inclinations and believe in and accept the concept of science for development, one of the many intervention programmers introduced to stem the deterioration of the prevailing conditions. The UN and its specialized agencies, like UNESCO, FAO, UNDP and other international donor agencies, have championed this concept of 'science for development'.

Science for Development Model in Ghana

Long before the adoption of the concept of 'science for development', the first President of the Republic of Ghana, Dr. Kwame Nkrumah had some genuine belief in the potency of science and technology to propel Ghana, and for that matter the whole of Africa, into a modern, civilized, industrialized and economically vibrant society. He must have been influenced greatly during his study periods in the USA and Britain.

Immediately after independence in 1957, he initiated many programmers based on science and technology for the rapid industrialization of Ghana. The University of Science and Technology, now named after him, (Kwame Nkrumah University of Science and Technology), was established in 1961.This was followed in 1962 with the establishment of the University College of Science Education, now called the University of Cape Coast, which was mandated to produce only graduate teachers in science for the secondary schools in Ghana. Next to follow was the Ghana Atomic Energy Commission, established at Kwabenya near the premier university, University of Ghana. To support these academic and research institutions, The Ghana Industrial Holding Corporation (GIHOC), comprising of sixteen (16) different industries was established about the same period.

Unfortunately when the government of Dr. Kwame Nkrumah was overthrown through a military coup d'etat in 1966, all the developmental programmers initiated were jettisoned overboard and since then no coordinated programmes based on science and technology have been presented. One would question whether the programmes initiated by Dr. Nkrumah based on science and technology would have been successful had his government not been overthrown. The answer could be 'Yes' or 'No'.

Considering that Nkrumah's government became dictatorial, operating in a one-party state with him as the life President, the chances of pushing through all the programmes to success are imaginable. He had succeeded to build the Akosombo dam to create the Volta Lake, which up to date is the largest man-made lake in the world, to generate cheap hydroelectric power to be used in the production of aluminum from bauxite.

Although Drori (1998) successfully debunks the notion of a causal link between science and technology for economic progress from case studies of the newly

industrialized countries (NIC), the case of Malaysia was an exception. Malaysia and Ghana both gained their respective independence status from Britain in the same year, 1957, with Ghana three months earlier. Just as Ghana, under Kwame Nkrumah, had a strong centrally controlled economy in a dictatorial regime Malaysia had a similar environment. In Malaysia, Lewis (1993) reports "access to science education is near universal at primary level and the quality of teaching and material resources is becoming comparable to that found in industrialized countries" (Lewis 1993, p.2). Under Nkrumah's government similar conditions prevailed. Incentives were given to students to study science in the universities. The allowances for students studying were higher than those given to non-science students. Science at that time enjoyed such high legitimacy and status that Dr. Kwame Nkrumah, the President instituted the Ghana Academy of Sciences, which has now been extended to cover the Arts and known as the Ghana Academy of Arts and Sciences.

Now, Malaysia is one of the newly industrialized countries, which has transformed itself since 1971 from a producer of raw materials into an emerging multi-sector economy with electronics as one of its main export products to the USA and Japan. As at the year 2000, Internet users in Malaysia numbered 4.1 million. With a healthy foreign exchange reserves and relatively small external debt, Malaysia is presently way ahead of Ghana which could boast of only 200,000 internet users as at the year 2000.Ghana remains heavily dependent on international finance and technical assistance and with its present economic harassment had no choice but to opt for debt relief under the Heavily Indebted Poor Country (HIPC) programme in 2000.

The differences in the situations in the two countries can only be explained by the political instability in the case of Ghana and the presence of a strong stable government in Malaysia. Also to be noted is the fact that whereas both Ghana and Malaysia had Britain as colonial masters, Ghana retained and still uses English, a foreign language, as the official language and the language of instruction in schools. Malaysia uses a local language, Bahasa Melayu as the official language and that for instruction in schools.

Dr. Kwame Nkrumah strongly believed in Pan –Africanism and worked very hard towards the unification of Africa under a Union government. In his drive for the African Unity he had problems with some leaders of the other newly independent African countries on policy issues and on ideological grounds. Nkrumah had socialist inclinations while some of the other Heads of States, particularly that of Nigeria at that time had capitalist tendencies. The colonial masters, particularly France, did not leave the their newly independent states free to do what they wanted. They had an agenda for them and advocated for 'assimilation 'with France. The British however acted differently leaving their former colonies to their own fates, designs and aspirations. Nevertheless Nkrumah was very skeptical of these former colonial masters and feared that they had schemes to perpetually bind them economically as neo-colonialist states.

A study of the conceptual model of science for development for use in the developing countries would lead one to concur with the skepticism of Kwame Nkrumah. The adoption of the science for development model in Ghana and elsewhere was to frustrate the drive towards the development of a truly

industrialized Ghana, directing its own research and development programmes. Nkrumah's dreams would have been stillborn.

One of the driving forces for the adoption of the science and technology for development model was the fact that during the 1950s and 1960s development theorists condemned indigenous local knowledge and technology and considered them as inefficient, inferior and indeed obstacles to the fight against poverty, hunger and underdevelopment. These theorists disregarded the mounting evidences for the success of indigenous knowledge and practices in the areas of agricultural production and sustainable development.(Altieri,1987, Brokensha,Warren and Werner,1980; Chambers, Pacey and Thrupp,1989,Warren,1991,1993).

Warren et al. .report 'Ten years ago, most of the academics working in the area of indigenous knowledge represented anthropology, development sociology, and geography. Today…important contributions are also being made in the fields of ecology, soil science, veterinary medicine, forestry, human health, aquatic science, management, botany, zoology, agronomy, agricultural economics, rural sociology, mathematics…fisheries, range management, and water resource management. (Warren et al. ,1993)

Indigenous knowledge has now been identified to be relevant in preparing development process that is cost-effective, participatory and sustainable.

Contextual Hurdles in the Ghanaian Situation

Regardless of whatever might have happened under Kwame Nkrumah's government, a very detailed analyses of the implementation of the conceptual model of science and technology for development have been provided by Drori (1998), which, citing from empirical studies clearly 'contradict our everyday notion of science education and the predictions made by the model of science education for development.' From their own studies Kamens and Benavot (1991, p.166) report "it does not appear that official attention given to mathematics and science instruction in primary education is directly related to key indicators of socio-economic development, economic dependence or world system position. The casual link between science education and economic development is at best mythical," Rutherford (1985) still maintains that the continued progress of the developed countries in respect of economy, security, global status and 'attractiveness to human society' would continue to be dependent on science education. Technological innovations are based on cumulative scientific knowledge for which science education is mover. Policy makers generally advance two of the outcomes of science education to include the creation of a technically skilled labour force and a knowledge-based economic growth. To achieve these two outcomes necessitates government control of and coordination between allocation of resources, market needs and educational supply. Guimares (1989) refers to the effective government involvement as the main factor for the economic success of the newly industralised countries (NIC), including Malaysia. Ghana, like other developing countries in Africa has not been able to establish links between university research and industry. Cooper (1973 p, 7), therefore advices African countries

to study how Japan succeeded to have effective, direct government control over the coordination of education, science and economic policies

The worldwide promotion of the 'science education for development model' by national and international organizations like UNESCO has virtually turned it into a global myth which has prompted the setting up of science tracks in primary and secondary school laboratories and directed the attention of politicians to the issue of science education (Driori, 1998) Some consequences of these may be economic development but as Benavot discusses 'the economic effects of science education may have more to do with " hidden" cultural rules, orientations and worldviews being transmitted than the specific scientific content being taught' (Benavot ,1992 p.173). In effect, serious consideration of the 'science education for development' may in the long run be found to be "just mere words" which reflect and promote a particular social context. The policy directives that may emanate from the adoption of the model may include the writing of text-books in English with foreign consultants, choice of pedagogical instructional materials recommended by the foreign consultants and the use of these teaching and learning materials to infuse certain facts and western worldviews in the pupils.

After the failure of externally induced and prepared development initiatives, attention is now directed to the participation of the indigenous and local groups in developing strategies that fit into their local conditions. Cultural barriers are mentioned among some social mechanisms that impede the success of the science for development model and Drori points out that 'such barriers impede the transfer of knowledge-knowledge that was created in a particular cultural context and thus is value- and symbol-laden-to another cultural sphere". (Drori, 1998).

Many cultural barriers do exist in the Ghanaian situation to stifle the implementation of the science for development concept. According to Benavot (1999,p.173) 'the economic effect of science education may have more to do with "hidden" cultural rules, orientations, and world views being transmitted than with the specific content being taught. 'The current push towards globalization necessitates worldview standardization of scientific education curricula and isomorphism (Drori, p.59). The role of science education, according to Drori, is twofold within the scheme of science education for development. These are

a). to shape positive attitudes towards modernization and

b). to train candidates in science and technology and prepare them for higher education and for sophisticated production roles" (Drori,)

Within the science for development model there is provision for professional training and for the provision of local skilled labor for the economy. This is based on one of the four major assumptions for the model and considers the role of science education as providing a lead to the preparation of scientifically- and technically- skilled labor force. With such skilled personnel it was expected that industrialization and economic progress would follow. Unfortunately this conceptual frame of science for developments is based on western science whose worldview, according to Cobern is grounded on the following three imperatives of modern western society:

I. The imperative of Naturalism—all phenomena can ultimately and adequately are understood in naturalistic terms;

II. The scientific imperative—anything that can be studied, should be study;

III. The technocratic imperative---any device that can be made, should be made. (Cobern, p.20)

From the above statements it is evident that the single logical goal of the western worldview is the material well being of the people. This position is captured by the statement of America's most prestigious scientific organization, The National Academy of Science:' In a nation whose people depend on scientific progress for their health, economic gains, and national security, it is of utmost importance that our students understand science as a system of study, so that by building on past achievements, they can maintain the pace of scientific progress and ensure the continued emergence of results that can benefit mankind" (NAS, 1984,p.6)

The current trend of industrial and economic development in the western countries clearly point to the adherence of the principles advocated by the American National Academy of Science. Some Americans are concerned about the one-directional outlook of economic and social development based solely on science and technology. Sadly their voices do not go far enough and their admonitions about the fact that there is more to life than economics are not heeded. Aleksandr Solzhenitsyn, the Russian writer has commented

> as creature comforts continue to improve for the average person, so spiritual development grows stagnant. Surfeit brings with it a nagging sadness of heart, as we sense that the whirlpool of pleasures does not bring satisfaction, and that before long, it may suffocate us…No, all hope cannot be pinned on science, technology, economic growth (1995,p.8-9).

Drori regards the science for development model to have its theoretical foundations on the structuralist-functionist modernization theory, which divides national development into stages. The hierarchy for the nation states has the developed countries on top with the Third world countries at the bottom. It is further stipulated that situations and events can be transferred from one nation-state to another. It is therefore possible for the least developed countries (LDCs) to follow in the footsteps of the developed countries to achieve the standards and economic prosperity and social liberties of the advanced developed countries. Since the progress of the advanced developed countries were achieved through the mechanism of science and education, similar progress could be realized through science and education.

The community into which the science for development model has been introduced is one where the people, the Ghanaians, some of whom have had contacts with western culture are still firmly attached to their traditional cultural background. They still practice profound ancestral worship and veneration .The belief is that ancestors offer protection to their descendants and in return are propitiated. This is unacceptable in the western culture whose science is being introduced. The relationship between elders and their juniors is still dependent on the respect for the aged. Children are expected to maintain low profile in the presence of their elders and are not expected to argue with them, since age has an ascribed social status in the Ghanaian community. The constructivist theory which is the basis for science teaching and learning

demands that the students construct their knowledge from active dialogue with their teachers, be very objective in their reasoning and be bold to raise questions about things they do not understand. This practice will not find favour in the Ghanaian context and will pose serious obstacles in the learning process of the Ghanaian science students.

The respect for age and authority, which are validated by traditional religious beliefs, will be confronted by the practice of constructivist theory in learning science. Since religion plays a major role in the daily activities of the Ghanaian, any programme, which plays down on the religious aspect, is bound to be rejected. For any outside program to be accepted the cultural context of the beneficiaries must be considered.

One of the main causes for the failure of the science for development concept in Ghana can be deduced from Cobern's statement 'accepting the tight, linear science –technology-economic development (STD) model squeezes out non-scientific ways of knowing and in doing so, creates for science (in its scientific form) a privileged status in society. As this occurs there is increasing pressure for other aspects of culture to conform to scientific thinking. Any areas of resistance come to be viewed as deficiencies because the areas of resistance impede the takeover by scientific rationality.' (Cobern, 1998, p.20-21)

It would be naïve for any one to think that the advocates of science for development in the developing countries would sit down unconcerned to have their efforts thwarted by local cultural practices. They are not only to transfer scientific knowledge but through that to impose the western culture on the people. According to Basala, the first task pertaining to the subject of world view is that;'a resistance to science on the basis of philosophical and religious beliefs must be overcome and replaced by positive encouragement of scientific research. (Basala, 1967, p.617).

This position is further given support by Poole who state;"it is difficult to see how the less advanced societies can achieve the high living standards at which they aim without assimilating large portions of the western conceptual systems, not least those concepts of scientific significance') Poole, 1968 p.57). In his book, *The Stages of Economic Growth*, Rostow (1971) discouraged the use of an indigenous scientific enterprise from the scratch when according to him, it was much easier to import a highly ready made and advanced body of scientific knowledge from abroad. The question to be answered is 'for whom would that knowledge be used, to whose benefit and for what purpose? 'Acceptance of this philosophy would only end up in making neo-colonialist states of these non-scientific developing countries. This exactly is the hidden agenda of the science for development concept and was to be a prelude to the current globalization movement.

The culture of western school science or worldview is described by Cobern as "scientist and one which alienates many students" (Cobern 1998.p19). Based on the logico-structuralism model devised by Kearney (1984, p.106), Cobern presents the descriptors of the seven categories that comprise a world in a tabular form, Table 1.

Table 1 Example Descriptors for Worldview Categories

Example descriptors for worldview categories		
Worldview Categories	Scientistic Descriptors	Alternative Descriptors
The Other or NonSelf	Materialistic, reductionistic, exploitive	Holistic, social/humanistic, aesthetic, religious
Classification	Natural only	Natural, social, supernatural
Causality	Universal, mechanistic, structure/functional	Context bound, mystical, teleological
Relationship	Strict objectivism, non-personal	Subjective, personal
Self	Dispassionate, independent, logical	Passionate, dependent, intuitive
Time and Space	Abstract formalism	Participatory-medium tangible

The descriptors were arrived at from extensive research and examination of the cultural form in which western science is embedded and compares them with the descriptors based on non-western worldviews. Cobern rightly deduces that the western scientific view of the world as presented in the classroom is often materialistic, reductionist and exploitative. (Cobern, 1998, p.19).

These descriptions are explicit in the traditional western dominance theme about and a Japanese observer comments;' in the western idea, man was not an ordinary part of nature. He was a specially privileged creature, and nature was subordinate to him… he was the master of the natural world, which was at his disposal to analyze, examine and make use of … since the natural world and the whole universe were manifestations of God's creation, the study of it was not only a useful but also a highly esteemed endeavor … Such an outlook provided some of the important religious motivation which fostered the development of modern science in the western world." (Watanabe, 1974, p.280)

The Ghanaian's relationship with the 'other' or the 'non- self' is holistic, humanistic, religious and completely in contrast to that of the western world view.

According to Ogunniyi, the world view of an African is monistic/vitalistic, while those of the western scientist is irrational/impersonal.(Ogunniyi,1983, p.84).With respect to the universal causality ,Okeobukola and Jejede infer that the African's attitude to cause and effect is teleological while it is mechanistic for the western scientist;; 'causality is seen in terms of volition and not in terms of mechanistic laws. Things do not just happen in the traditional African society: events have a cause, but that cause is seen in personal terms" (Okebukola and Jejede, 1988, p.3) Within the concept of the science for development, the Ghanaian student is expected to be objective and non-

personal, which are not part of his/her descriptors in the logico-structural model of world view.

A story is told of a father in a Ghanaian farming community who consistently refused to allow his only child, a boy of 12 years to accompany his friends to the forest. On the day that he allowed his son to go with his friends, there was an accident in the forest. A big tree fell and hit his son on the head, killing him instantly. The following questions agitated the mind of the grieving father:

i. Why did he allow the son to go to the forest with his friends on that particular day although he had consistently refused the request on previous occasions?

ii. Why did the tree fall, not on anyone in the group but on his only child on the very first day that he joined the group

iii. Who fell that tree which was standing erect.

The cause of death in a Ghanaian community is an important issue for consideration since a tragic death through accident is regarded 'unclean' and could be due to gross and persistent violations of the sanctions of the gods and ancestors. Ghanaians believe that babies are a creation of God and that after birth babies are given to families on loan by God and for specific purposes. Parents therefore go to all extent to find out from the deities about the character and nature of their babies, the purpose of their creation, their destiny or what the babies would become.(Kuamuah,2000,p.8).

This grieving father would be worried to find out whether a god or a spirit and what would have been his sin to make him incur such calamity inhabited the tree. His dilemma would not be answered from purely scientific, materialistic, reductionist, mechanistic, strictly objective, non-personal and dispassionately independent logical ways of thinking that would have been the method of the western scientist.

The western scientist presents his world view as superior to that of the non-scientist and it is this assumed privileged status of the western world view that prompted the Maori intellectual, Linda Smith to write 'it appalls us that the west can desire, extract and claim ownership of our ways of knowing, our imagery, the things we create and produce, and then simultaneously reject the people who created, developed those ideas, and seek to deny them further opportunities to be creators of their own culture….(and) deny them the validity of their own knowledge. (Smith 1999,p.1)

It must be realized that the western worldview had evolved over many centuries from the 16th.to the present and had resulted in the present materialistic and non-spiritual attitude where power and dominance of nature and other cultures is the goal of development. Based on the logico-structural model of worldview one can identify worldviews that are different but yet scientifically compatible and acceptable. If this existence of scientific pluralism were acknowledged and accepted, wholesale export of a foreign worldview would be discouraged. Hewson (1988, p.317) has recommended that 'rather than continuing to encourage the west to donate scientific knowledge and skills to developing countries, a different approach might usefully be taken.

Critical dialogue between the west and the developing countries could promote conceptual change of the knowledge bases of both and allow for the emergence of a new type of science that is effective in meeting specific problems at a range of levels in developing countries, and possibly in the west as well. (Hewson, 1988,p.317).

This dialogue would have to take into consideration the religious nature of the Ghanaian and therefore take note of what Orzel warns against 'Now everywhere is a market. There is nothing, which has not become a commodity that can be bought and sold. The market with its impenetrable mechanism, its shrines, banks, production and consumption armies, serve as a god for those who have gone astray from religion' (Orzel, 1992,p.32.)

If science were to accept that there is room for other views, room to ask questions and room to accommodate other perceptions, then it can grow into a truly universal discipline, which will receive back most women, and men who have rejected, science. (Stocklmayer p.8).

In her book *'Whose Science,Whose Knowledge?',* Sandra Harding (Stocklmayer 1991. p.8), advocates for science which is more diverse and is more embracing of other world views. Cobern opines, " Science educators speak of authentic science in the classroom, and science instruction that model science. Science educators speak of fostering in students a scientific worldview, which presumably means the worldview of scientists. However, the point… is that the scientists drawn from the world over do not compose a single, homogenous group of people that can accurately be said to have a single worldview. If that is the case, then the goal of authentic science in the classroom means that worldview study in science education must include a focus of the worldviews of scientists *in culture*. Failing to do so means pursuing a scientific outlook out of context."

If indigenous knowledge systems would not be described as 'backward, naïve or misconceptions, but rather recognized as alternative conceptions, a lot of progress would have been made in respect of science education in the developing countries and their local scientists would gain the confidence of applying their to the solution of the local problems. They would not wait for solutions to come from outside their local domain. Imposing a specific foreign world view on any nation because of their need for economic and social development will not achieve much because of the entrenched cultural backgrounds of the recipients and their inherent attitude to resist external influences and encroachment on their cultures.

The science and technology concept has failed in Ghana because of the failure of the government to see beyond the 'catching up' syndrome that refuses to consider building on the Ghanaian cultural background. The whole exercise of catching up on development is a mimic of western development. Mahatma Ghandi is reported to have said of a woman trying to behave as a man thus "she can run the race but she will not rise to the heights she is capable of by mimicking men". The government of Ghana fails to realize that any particular technology exists within and is intimately related to a particular social context. The Ghana sages have said 'It gives the teeth of a child more strength to

struggle for nought with the hard bone of a chicken's foot than to fiddle for sweetness with a piece of soft sugar cane'.

The Language Factor

A major problem with the teaching of science is with its communicating. The possibility of communicating the wrong idea is very high and this would leave the students more puzzled than before. The Ghanaian students already consider science to be 'hard' and difficult to understand and also not very important for real life. Learning of science is considered to be done by rote acquisition of facts and formulae, which have no bearing or relevance to their daily life. Learning of science is made more difficult if it has to be taught in English, a second language, by teachers whose knowledge of the English language is shallow.

In all learning processes, the medium of instruction has a major role to play since it is related to both attitude and cognition. In Ghana knowledge of the English language commands a prestigious position as it provides access to jobs and economic power. The image of science for development is thus complicated by the need to gain control over the English language.

A lot of studies have been done on the challenges of learning science through a second language like English. Strevens (1980) has two categories of learners of science using English as the medium:

i. Those who have come to an English –speaking country having received part or all of their schooling in another language and

ii. Those who are citizens of a multi-lingual country where the language of official communication is English and who are officially taught at school through the medium of English

The Ghanaian falls into the second category and encounters English for the first time at school. Textbooks are written in English, class assignments are to be done in English and examinations are also conducted in English. Krashen (1982) distinguishes between language learning and language acquisition and associates those in Strevens' second category, like the Ghanaians to be more engaged with language learning. Because of the slow and ineffective start with the second language, there is bound to be a mixture of language acquisition and language learning for this category.

Cummins (1980) has, however, noted a contrast between conversational and academic language proficiency for the second category. This group has difficulty in expressing ideas in writing. They can articulate an oral understanding of a concept but have difficulties in communicating these ideas on paper. The members in this group are therefore found to give the general impression of poor performance at written examinations. From his studies Rutherford (1993) considers problems associated with expressing scientific ideas in African languages more to do with vocabulary, logical connectors and multiple meanings of words. Conceptual difficulties in learning science have also been identified. Inglis(1993) has observed that the quality of the writing skills of students are related to their conceptual understanding of the content of the science assignment. The inference is that poorly written science assignments may be due either to poor language proficiency or to weak conceptual

understanding. Similar observation has been made by Rollnick et al. (1992) who include also traditional thinking and culture as impacting on science learning. Rollnick(1988,p.232) states: 'the student in Africa has one name which is used at school and another name which is used at home. There is one type of acceptable behaviour at school and one at school. There is one type of dress for school and one for home. There is a language for school and a language for home. Because of this the student too becomes two people.' Language is indeed part of the learner's culture and words and meanings are based on cultural backgrounds.

Oral transmission as a means of passing knowledge from generation to generation also has effects on learning science. Certain conventions are important in the oral transmission as they mediate thought processes and may not be compatible with or acceptable in scientific writings. Although literacy is on the increase among Ghanaians the rate is too slow to overshadow oral transmission. Prophet and Dow (1994) from their studies in Botswana have observed that scientific concepts attainments are greatly influenced by the language of instruction. Collison (cited in Rollick) has also noted that the Ghanaian pupils made higher cognitive level statements in class discussions when they used the local home language than when they use d English language, the official language of instruction.

From a theoretical consideration of the role of language of instruction in science teaching and learning, it is evident that in a situation where that language is a second language for the students, there would be considerable difficulties in the teaching and learning processes. These difficulties would impact negatively on the progress and success of the concept of science and technology for development in Ghana.

Alternative Strategies

The need to look at other directions and policies, which take due cognizance of the cultural differences in order to bring real developments to the people of the developing countries is long overdue. In so doing one should not ignore the pervasive efforts of the western sponsored institutions like the World Bank/IMF and their collaborators in various schemes to execute their hidden agendas under the guise of globalization, standardization and homogeneity of science curriculum in primary and secondary schools.

An African proverb has it that "when lost, it is better to return to a familiar point before rushing on." The perception that anything indigenous is synonymous with lack of progress and innovation must be vehemently rejected. It is now generally accepted that successful development strategies must have indigenous knowledge as a component in the planning.

Africa presently stands at a crossroad in search of a new vision of development aimed at eradicating the preventable diseases, alleviating the poverty and establishing human rights and the promotion of human dignity based on traditional practices and culture. The affluence of globalization should in no way blindfold the political leaders since it is just a minority in the society who are benefiting. It is unfortunate that some aspects of the colonial heritage, in

particular the educational system with the science that accompanied it have become an albatross on the necks of governments in most African countries.

'Development from below is for many reasons, a more productive approach than that from above, and …an essential ingredient is indigenous knowledge…To incorporate in developmental planning indigenous knowledge: is a courtesy to the people concerned; is an essential first step to successful development; emphasizes human needs and resources, rather than material ones alone; makes possible the adaptation of technology to local needs; is the most efficient way of using western "Research and Development" in developing countries; preserves valuable local knowledge; encourages community self-diagnosis and heightens awareness; leads to a healthy local pride; can use local skills in monitoring and early warning systems; involves the users in feedback systems , for example, on crop varieties.

These positive reasons –together with the negative reasons, such as the likelihood of failure without using indigenous knowledge- constitute a strong case for incorporating this knowledge in development programs' (Brokensha et al. 1980:7-80)

From their study into indigenous systems of innovation in East Africa Bertelsen and Muller (2001) point to the existence of two systems of learning in Tanzania, one in the formal sector and the other in the informal sector. They draw attention to the fact that efforts to transfer scientific and technical knowledge from the western industralised nations to the developing countries without concern for their cultures would fail. Pradhau advices: 'science education, in any country, is certainly a systematic and sustained attempt at communication about nature between a scientific and a non-scientific or a partially scientific community and as such it should be particularly sensitive to the attitudes and presuppositions of both the scientist and the student' (Pradhau, 1967, p.649.)

Cobern agrees 'science content is science content, regardless of culture, but not so much with its communication. Communicated science, which includes science education, is embedded in culture' (Cobern, 1998, p.18).

1. Knowledge acquisition in the Formal Sector

In Tanzania it was observed that the euro-centric perception of what knowledge is about is the trust in the formal system of knowledge acquisition. Similar situation can be found in Ghana. Wackerhansen (1999) has identified five 'dogmas' as the basis for knowledge acquisition in the western industralised countries:

a. Knowledge is understood as being explicit in something that is being or can be articulated in a linguistic way. Thus knowledge can be externalized in relation to humans. It becomes an object, something that can be moved around, stored , sold or bought.

b. Human qualifications are based on rules that can be described. These rules are based on or developed from a rational professional expertise and can be written in a set of regulations.

c. Combining the above two perceptions, professional competence is seen as being generated from explicit knowledge combined with rule-based skill to solve problems in ones professional domain

d. Possession of a relevant data bank of knowledge related to a profession is required in order to become a professional craftsman.

e. The single individual is the subject for learning and competence. The one that learns is the one who has the competence.

These five 'dogmas' are used to guide the training of craftsmen in the formal sector. With these perceptions formal training as craftsman has become institutionalized in an educational system where practical traineeship has gained less and less attention in Tanzania. The informal apprentice system is still around although it is not part of the formal educational system this situation also prevails in Ghana.

2. Knowledge Acquisition in the Informal Indigenous sector.

The knowledge acquired by craftsmen in the informal sector is based on experiential and implicit learning with a high degree of tacit knowledge. Although competence is being developed there is no documentation and there is very little verbalization. In such a system the apprentice learns to produce a range of specialized products and also learns to cooperate with other craftsmen, customers and to move within the community and society as such. The learning that takes place through experience is grounded in a mentor-protégé system for skill transfer.(Nsana,2001).In order to survive in the rural areas and in the towns the craftsman must depend on an acquired ability to navigate in a cultural, social and family networks and settings. In a rural setting there exists diversity, complexity and high degree of uncertainty. To survive in this setting the craftsmen must acquire other different skills through different types of informal apprentice systems. They should be capable of more than one craft. This will depend on the quality of the crafts as well as the proportion of basic knowledge and local time and place knowledge that are required for that particular craftsmanship. The core norms and values are determined according to the basic understanding of how, why and when people in the community act. Learning and education systems development in the informal sector are therefore more about developing the skills and qualifications strictly required for a particular craft. The informal knowledge depends on personal qualifications acquired by and embedded in that person who has learnt that craft.

The Potential for Development

Mobilization of indigenous knowledge and technology are very necessary for social transformation. For example, the technology of the village blacksmiths is extremely labour demanding, cumbersome and low level productive. But for as long as the agricultural technology is based on relative simple tools there will always be a need for the intimate knowledge of the blacksmiths about the particular crops and soils of the particular local areas. Whether animal drawn ploughs or other implements will be introduced will depend on the ability to have a localized adaptive technological capability and repair capacity.

Admittedly, the application of modern western science and technology for development is showing success in the western countries because of the milieu they are operating. In the present era of globalisation, the future of developing countries is in jeopardy as it is very easy to be marginalized and thus left in

more poverty, disease and lack of social development if the cultures and practices of the developing countries are replaced by foreign cultures through schemes developed elsewhere and imposed on the poor developing countries.

The experience of the Japanese in not succumbing to the encroachment on their culture by the west through western science for development is an example worthy of emulating. The Japanese accepted that science is a constructed artifact, which must be culturally based. This was their basis for their success." Science to them is universal for other people and as such science education must be an interpretation based on the Japanese image of science and what they, the Japanese think it should be. There is, thus, no culture-free interpretation of science or science education. The Japanese accepted that the ideas and methods of western science could be adequately taught in Japanese schools within the traditional Japanese worldview of nature, even though the results may appear strikingly different from the western practice of science education" (Ogawa,). Ghanaians have to learn from the Japanese in their border crossing into western science for development. The statement exemplifies the Japanese attitude 'I may wear a western suit, but I have a bamboo heart' The Ghanaian should be taught to say 'I may wear a western suit but I shall retain my neem heart'.

Conclusion

The present situation in Africa with regard to development is indeed very bad and has prompted President Thabo Mbeki of South Africa to designate this period as the moment of the African Renaissance in which 'we are our own liberators' (Mbeki, 1999). The South African president elaborates further by saying "An essential element of the African Renaissance is that we must all take it as our task to encourage her, who carries this leaden weight, to rebel, to assert the principality of humanity –the fact that she, in the first instance, is not a beast of burden, but a human and an African being'. (Mbeki, 1999) In this context science educators and technologists have a major role to play if 'She' is not to be seen as a 'beast of burden but a human and an African being". The call to rebel must be taken seriously. The rebellion must be in the mind first, relieving the mind of considering the number of four-wheel -drive cars on the road, the number of cellular phones in the system, the number of people with access to the Internet etc as indices of development. These are all desirables but not necessary in the face of the extent of diseases in the community, lack of good quality potable drinking water, good housing shelters and the unacceptable extent of poor sanitation in the communities in Africa. African scientists must stand up and inform governments that just establishing the structures of western democracy in Africa do not of necessity lead to the eradication of diseases, provision of good drinking water etc. The amounts spent on the establishments of these structures of western democracy to ensure freedom of speech, rule of law, separation of powers etc. with the concomitant provision of fringe benefits for the politicians reveal lack of concern for the ordinary person whose needs are very basic and ordinary. These basic needs are not outside the capabilities of the local scientists and technologists to provide. In Ghana for example the problems associated with food are. not in the production but are related to post harvest losses. It is known that a lot of research work has been done and documented by the Food Research Institute

in Accra. Similarly the innovative craftmanships displayed by the artisans at Suame magazine in Kumasi should put Ghana way ahead in technological practices to solve basic problems associated with housing, agricultural machines, and transport. Relying on imports is not a way of ‘encouraging her who carries the weighty burden to assert herself ‘(Mbeki 1999). According to Rogers:’ We cannot change, we cannot move away from what we are, until we thoroughly accept what we are’ (1980.). What are we now? One may ask. We are very poor, messed up and entangled in preventable diseases, which makes one to wonder whether it is worthwhile to bring forth children, as on the first day of birth, these children become sources of sorrow not of happiness. The pictures of these dying babies become the object of ridicule in the western electronic and print media.

Universities and other tertiary institutions in Africa cannot stay aloof in this in this fight against poverty, diseases etc. As Tema (2002) recommends Research students imbued with the spirit of contributing knowledge that would help rebuild their countries, would reject the idea of conducting research solely on the basis of the supervisor’s agenda. They would have the boldness to present research proposals that ask authentic questions. They would also feel challenged to respond through research to statements by researchers who have attempted to compare African and modern Western thinking.’ Tema continues “the African scholar also has to take up the challenge of bringing traditional African knowledge into the classroom and to conduct his or her own critical analysis…African researchers should also take it upon themselves to explicate African beliefs and conceptions, such as those that conflict with modern medicine.”

Irzik(1998) is of the conviction that the business of science is to supply the facts about the world from the western perspective, but not to indulge in the values and value judgements. Bulac (1998) challenges the needs for the products of western technology. He asserts that people have lived for centuries without TVs, refrigerators, computers, etc. Products which are not necessary for survival are being promoted by western powers to encourage consumerism of their products and indirectly make the developing countries dependent on western economy and technology through neo-colonialism.

There is every indication of hope for the development of the third world countries if the advocates of globalisation would appreciate what Irzik admonishes “that the way to acquire knowledge of the world is not independent from the institutions, practices and discourses that produce it and does change historically”. This statement is indeed a restatement of Feyerabend’s pluralistic relativism that states ‘every culture, every nation can build a science that fits its own particular needs’ (Feyerabend, 1989). Ogawa (1989) also states ‘every culture has its science’. There are as many kinds of science as there are societies which makes it irresponsible and without any grounds for any one to claim a cognitive superiority over the others. The solution lies in recognizing your own and upholding it there is nothing wrong about learning other worldviews and incorporating the good and acceptable portions into one’s own.

Wholesale importation of development plans, devised and drawn within the western worldview will never succeed in any developing country. The indigenous knowledge which is undervalued and which is disappearing needs to be

resuscitated and be made the pivocal resource in the search for development. This way is technically the easiest and most convenient. It is up to the politicians and their advisors to realize this and accept it. Rome was not built in a day. If it is realized that indigenous knowledge is derived within the immediate context of the livelihoods of the people and as such it is dynamic there would be constant modifications as the needs of the people and society change.

President Olesegun Obasanjo of Nigeria, in his plenary address at the World Education Forum declared in part 'The global village of the new century cannot afford (for reasons of equity, equality of nations and world security) to have impoverished ghettos in its fringes. It is, in fact in the interest of the richer countries to come urgently to the assistance of the poorer ones. The operative word is assistance-that is technical, logistic and financial help in articulating endogenous ideas for development and seeing them to fruition. as well as in strengthening individual and institutional capacities.'

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Energy Efficient Lighting in the Residences of staff of the University of Education, Winneba

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Abstract

It is estimated that 15% of electric power production is used for lighting consumption in Ghana. This figure is likely to increase as the country develops. There is no doubt therefore, that improving the energy efficiency of lighting in Ghana could have a great impact on Ghana's energy consumption, and subsequently, on the economy. The study is to investigate the level to which energy-efficient lighting systems are being used in some selected bungalows at the University of Education, Winneba, in Ghana. Forty bungalows were selected for the survey. A questionnaire was used to ascertain information on compact fluorescent lamp (CFL) as an energy-efficient lighting system. The results of the study show that even though academics in the university have received information about the use of CFLs as a way of saving energy, very few show interest in their use. It is inferred that lamp prices could be a more important influence on consumer's choice of efficient lamp than the cost of electricity. Market barriers, such as cost of and fundamental problems with the use of CFLs are discussed along with appropriate remedies.

Introduction

Energy production and use impose significant economic and environmental costs on Ghana. Given the ever-growing population and standard of living in the country, the current electricity demand-and-supply relationship cannot be sustained much longer. The combination of growth in population and building of infrastructure will cause for example lighting demand to grow quickly, probably faster than overall electricity demand.

One area in which consumption of electricity is prominent and in high demand is household lighting. General incandescent lamp and linear fluorescent lamp-types are most popular lighting fixtures in Ghana. However the low-priced, luminous and popular incandescent lamps consume a lot of electrical energy due to the high wattage, and operate at high temperatures resulting in increase

in the ambient temperature of a room. The minimum temperature of 121˚C is typically associated with 100-watts incandescent lamp of tungsten filament type (Mills, 1996). Linear fluorescent lamp also gives significant inefficiency. Market survey on Incandescent lamps indicates that approximately two million of these lamps are sold each year in the country. Considering its high level of inefficiency, it implies that there is a lot of wastage in the system. This in no small way contributes to a lot of wastage in terms of electricity consumption. There is therefore the need to find alternative ways of household lighting to conserve energy.

An alternative lamp type called compact fluorescent lamp (CFL) is recommended. This lamp-type offers benefits in terms of energy cost-control. There is fire-safety improvement on the highly efficient compact fluorescent lamps (Page et al. 1997). The maximum temperature of the compact fluorescent lamp is approximately 60˚C far below that of the incandescent lamp. It must be noted that energy-saving alternatives such as compact fluorescent lamps actually pay for themselves many times over in terms of energy cost savings (Mills, 1996). Table 1 shows the lamp performance standard indicators.

Table 1 Lamp performance standard indicators

Lamp type life (hours)	Wattage	Efficacy (lumens/W)
General incandescent (100-1000)	15-100	7-18
Linear fluorescent (1000-3000)	6-125	25-40
Compact fluorescent (3000-5000)	4-28	40-65

(Courtesy: G.F. Min et al)

According to Johansson et al (1989), there is a large potential for improving the efficiency of lighting and all other major electricity end uses at a cost less than that of building new power plants. However continuing shortfall between electricity demand-and-supply, the escalating cost of building new power plants as well as the competing needs for investment capital from donor agencies are just some of the obvious reasons why Ghana is ripe for improved energy efficiency in lighting and other end use areas.

Moreover, power shortages are attributable in part to peak demands caused by lighting and air-conditioning in the major cities. The basic problem is the means to improve efficiency. Lack of clear direction and comprehensive policy from the central and local governments and lack of incentives for energy efficient products mitigate the need for energy efficient lighting. Looking at the economic base of Ghanaians and the high cost of energy efficient lighting systems, typical Ghanaian consumers prefer lighting systems that are less expensive. However these less expensive systems are inefficient resulting in energy wastage. Therefore, there is a very clear indication that the Ghanaian consumer is more interested in saving money and has either very little interest or no knowledge at all about issues on energy conservation. Further more because the price of electricity is not so high, the average Ghanaian does not see the need to buy high priced CFLs for the purpose of conserving energy.

According to Bartlett (1993), those who patronise the use of CFLs as well as those who do not are motivated by a number of factors including economic and non-economic factors. He further observes that these factors could help shape consumer attitudes, and that educating the people on environmental protection through energy saving devices is often the most important non-economic motivation. Brond (1990), has also observed that, generally, studies carried out in other places such as France and Sweden indicate that merely giving information on the use of CFLs as energy saving device is not as effective as providing financial incentives such as lowering the cost of CFLs.

Methodology

The study considered all the staff bungalows on the three campuses of the University. However, forty (40) living bungalows on the North campus were purposively sampled for the study. A questionnaire was distributed to the occupants of each of the selected bungalows. The questionnaire was used to ascertain the following:

- Level of knowledge of CFL.
- Level of patronage of CFL.
- Quality of lighting provided by CFL.
- Level of acceptance of the amount of light provided by CFL.
- Cost of CFL as compared to incandescent.
- Degree of economic motivation.

Responses to the questionnaire were converted into percentages.

Results

Responses to the questions on CFL

Responses made to items in the questionnaire are summarised in Table 2. The table shows that 82.5% of the respondents have obtained information and therefore have knowledge about CFLs. However, when it comes to the information or knowledge about CFLs as energy-saving device, the number reduces to about 72%. It means that though a lot of people have some information about CFLs, some are not aware of the purpose CFLs serve, that is, they are not aware that the essence of CFLs is to save energy.

It is interesting to note that even though a lot of people (82%) have knowledge and information about CFL, when it comes to their intentions or plans to replace some of their lamps with CFLs, the number drops to 71%. Taking into consideration that about as many as 72% have knowledge about CFLs as energy saving device, one would have expected that almost the same number would be interested in buying additional CFLs. However, the number drops to 56%. It could also be observed that only half of the population have received some form of promotional literature on energy-efficient lighting such as CFLs. When it comes to quality level of illumination provided by CFLs, about 82% affirmed that they were satisfied with the light provided. One would have expected that the use of such energy-saving device would reflect on the

electricity bill in such a way that cost would go down. However, only 45% indicated that there was a decrease in electricity bill.

Table 2: The responses given to questions on CFL.

Item	Yes	%	No	%
Knowledge or information about energy-efficient lamp	33	82.5	7	17.5
Knowledge about CFL as energy saving device	29	72.5	11	27.5
Plans to replace other lamps with CFLs	27	71.0	11	29.0
Future plans to buy additional CFLs	9	56.0	7	44.0
Receiving promotional literature or information on energy-efficient lighting	21	52.5	19	47.5
Satisfaction with amount of light provided byCFL	9	82.0	2	18.0
Significant decrease in electricity bill	5	45.0	6	55.0
Payment of cost of CFLs by cash directly and not through electricity bill	23	69.7	10	30.3

When it comes to the payment of the cost of CFLs, 69.7% opted to pay by cash directly while 30.3% wanted to pay gradually through electricity bills. Several other reasons were to each of the following categories:

a) Direct payment by cash:

- Paying monthly bills could be unreliable. Thus there could be over payment.
- Not interested in credit buying.
- Inability to cope with large bills.
- Cost of CFLs is manageable and therefore there is no need to spread the payment through the electricity bills.
- Possible regular increase in price due to unstable exchange rate.
- Electricity bills being subject to manipulation and sometimes questionable.
- Preference for the true reflection of electricity consumption on the bills.

b) Payment gradually through electricity bills:

- Cost of CFL is high and therefore supplying it on credit basis and deducting gradually through electricity is better.
- Avoidance of fraud through the purchase of the CFL.

- Easier to make payment gradually via electricity bills.

Light lamps installed in bungalows

Table 3 shows the number of light lamps installed in the bungalows. It shows that only 3% of the population use CFLs whiles 52% and 45% use incandescent and fluorescent lamps respectively. It is quite striking to observe that as many as 72% (table1) know that CFLs serve as energy-saving device. However when it comes to the use, only 3% are interested. This may be due to high cost of CFLs.

Table 3 **Light lamps installed in the bungalows**

Type of light lamp	Frequency	%
Compact fluorescent	13	3
Incandescent	225	52
Fluorescent	194	45

The cost of a CFL at the Electricity Company of Ghana is ¢11,200, while at the open market it costs as much as ¢28,000. The cost of incandescent lamp (tungsten filament) is however, as low as ¢2,500. The vast difference between the cost of CFL and incandescent lamp may contribute, to a large extent, to the low patronage of CFLs. It can be seen clearly that the immediate concern of people is to save money and not energy. Respondents also indicated that despite the good quality of light from CFLs, it is short-lived, if it is at a point where there is intermittent on- and-off regulation of electricity.

Incandescent lamps used in bungalows

Table 4 shows the number of 40watts and 60watts incandescent lamps used in the bungalows.

Table 4 Incandescent lamps used in bungalows

Wattage	**Number**	**%**
40	10	29.4
60	24	70.6

It was also observed that 60watts incandescent lamps were the most commonly used. This could be attributed to the quality or intensity of light as compared to the 40watts lamps.

Reasons for patronising or not patronising CFLs

Tables 5 shows the reasons why some of the respondents patronized CFLs while Tables 6 shows why others did not. It was observed from table 3a that more people (23.0%) patronise CFL for energy saving purposes while about 20% use CFLs for the purpose of saving money. This seems to contradict the previous observation, which indicates that

more people patronise CFLs to save money (table 4a). This observation is quite interesting. It has already been observed and stated that as many as 82% of the respondents have knowledge of the use of CFL as energy-saving device (Ref. table1). It is therefore not surprising that such a reason for patronising CFL tops the list. However, when it comes to practical use of it, that is the actual use of the lamps, a lot of people will shrink from it because of the cost involved.

Table 5 Reasons for patronising CFLs

Reason	Frequency	%
To save energy	18	23.0
To save money	16	20.5
Lamp last longer	13	16.7
Desire to use a new lamp	1	1.3
Provide quality lighting	9	11.5
Lower temperature and does not make surrounding warm	13	16.7
Concern for the effect of high energy consumption on environment	8	10.3

Table 6 Reasons for not patronising

Reason	Frequency	%
Not interested	1	5.1
Do not see any reason	2	5.1
It is too expensive	7	18.0
There is no financial incentive	2	5.1
There is inadequate information on use of CFLs	14	35.9
Inability to find the right CFL	8	23.1
Issues on energy consumption are not quite clear	3	7.7

The reasons for not partronising the CFL seem to confirm the above observations. This is in agreement with the observation made by Brond (1990) that generally, studies carried out in other places indicate that merely giving information on the use of CFLs as energy saving device is not as effective as providing financial incentives such as lowering the cost of CFLs.

As much as 18% (table 3b) mentioned the cost as one of the reasons for not patronising, that is CFLs are too expensive. Again, 35.9% said there is inadequate information on the use of CFLs. Thus, even though a lot of people have information on the CFL as energy-saving device, they have very little knowledge about its use and the problems or benefits associated with it.

Further more, about 23.1% mentioned that they could not find the “right” CFL. Perhaps the idea here is that they are not able to find CFL which can last quite a long time considering the intermittent on- and- off regulation of electricity or the appropriate wattage to buy.

Analysis of electricity consumption between Incandescent and CFL.
The responses showed that an average time for use of lamps was **9hours** per day and the average light points for each bungalow was 13points. The calculations are therefore based on an average of **9hour**s per day of use of lamps.

Life span of Incandescent and CFL
Incandescent: The Incandescent lamp has a life span of 1000hours (*Ref. Page 2*).
No. of hours used daily = 9hours
No. of days of use = $\frac{1000}{9}$
This is equivalent to approximately 4months.

CFL*:* The CFL has a life span of 5000hours
No. of hours used daily = 9hours
No. of days of use = $\frac{5000}{9}$
This is equivalent to approximately 18 months.

The above calculations indicate that an incandescent lamp may be replaced about five times before a CFL is replaced.

The replacement of an Incandescent lamp compared with the life span of CFL will cost approximately ¢12,500, that is 5 x ¢2,500. The Electricity Company sells one CFL at ¢11,250. Thus, considering the cost involved in the replacement of Incandescent lamps vis-à-vis CFL, it would be more expensive to rely on Incandescent lamps.
However, it would be more expensive to buy CFL from the open market as it sells between ¢20,000 and ¢28,000.

Cost of electricity consumption between Incandescent and CFL
The calculations were based on the following:

No. of days of use of lamps = 30days (1month)
Predominantly used Incandescent = 60watts
Electricity Tarriff (from ECG, Winneba Branch):
50kW @ ¢7,500 block
51 – 150kW @ ¢242 per unit
151 – 300kW @ ¢304 per unit
301 – 600kW@ ¢570 per unit

Incandescent:
Energy consumption, $E_c = Pt$ (*where* P *is Power, and* t *is time of use of electricity*)
$= 60 \times 10^{-3} \times 9 \times 30$ kWh
$=$ <u>16.2kWh</u>

If all the points were on Incandescent, the total energy consumption for the 13 points would be, E_C = 16.2 kWh x 13 = 210.6kWh.

Cost of electricity:

50kWh	=	¢7,500
51 – 150kWh	=	100 x ¢242 = ¢24,200
151 – 210.6kWh	=	60.6 x ¢304 = ¢18,222
Total cost of E_C	=	<u>¢49,922</u>

CFL:

$$\begin{aligned} \text{Energy consumption, } E_c &= Pt \\ &= 20 \times 10^{-3} \times 9 \times 30 \\ &= \underline{5.4\text{kWh}} \end{aligned}$$

If all the points were on CFL, the total energy consumption for the 13 points would be, E_C = 5.4kWh x 13 = 70.2kWh.

Cost of Electricity:

50kWh	=	¢7.500
51 – 70.2kWh	=	20.2 x ¢242 = ¢4,888
Total cost of E_C	=	<u>¢12,388</u>

Comparing the consumption rates of energy for the two lamps, it is observed that in one month, CFL consumes far less than the Incandescent lamp (70.2kWh as against 210.6kWh). It can therefore be concluded that the CFL can be used as an energy saving device. Again, considering the cost of consumption of the two lamps the use of CFL is cost-effective. It clearly shows that even if the CFL is bought at the open market at ¢28,000, it will still be cheaper.

Conclusion

The study clearly shows that consumers prefer lighting systems that are less expensive (i.e. Incandescent). This observation is in agreement with the statement made earlier that the economic base of Ghanaians and the seemingly high cost of efficient lighting systems compel the average Ghanaian to go in for lighting systems that are less expensive.

It was observed that even though 82% of the respondents have obtained information and therefore have knowledge of CFLs, and 72% know that CFLs serve as energy saving device, only 3% use CFLs. It is important to mention here that 69.7% of those who use CFLs opted to pay cash directly than to pay for the cost of CFL through electricity bills, the main reason being that, very often, bills sent to consumers are unreliable. Sometimes, estimated electricity bills are sent to consumers. Considering the long-term benefits, CFLs serve as energy saving device. The additional advantage is the reduction in the cost of energy consumption, that is, the use of CFLs help in cutting down electricity bills.

Recommendations

Based on the observations made above the following recommendations have been made:

1. There is the need for the government to help in lowering the cost of CFL. One way by which this could be done is to reduce the tax element on the importation of CFLs.

2. The utility companies must ensure that information on the use of CFLs includes financial incentives such as providing discount facilities to the low income groups to enable them patronise the use of CFLs.
3. There should be clear direction and comprehensive policy from the central and local governments on the use of CFLs as energy saving device.
4. The true cost of electricity consumption must reflect on the bills without subsidy from the government. This will create the awareness of the need to conserve energy and so make the use of CFLs quite attractive.
5. The Electricity Company must ensure that more reliable bills are sent to consumers to enable them know their energy consumption pattern. The company should also be made the sole agent for the sale of CFL to attract its use.
6. The Electricity Company should intensify its educational programs on the use of CFLs.

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Planning Imperatives for Sustainability of Qualitative Educational Enterprise in Nigeria: The Role of the Educational Planner

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Abstract

Planning Education is a prerequisite for achieving gains in educational enterprise. This paper presents prescriptions, which planners should adopt as a frame-work to do effective planning and implementation of educational programmes in Nigeria. The paper discusses National aspirations, National challenges, result-oriented planning, imperatives for goal achievement, and levels of education in Nigeria. Important suggestions are presented as recommendations drawn from the write up.

Introduction

The Nigerian educational system has often been criticized for poor planning inherited from colonial masters (Thompson 1981). It has been condemned for being unable to meet the needs and aspirations of the country as a result of its non-functionality, irrelevant curriculum, unrelatedness of the learning experiences etc. (Ozigi & Canhan, 1979:194). The education process has been found to be faulty, inadequate and inefficient for Nigerian purposes e.g. non-achievement of national goal of technological transformation. The big question is: How should education in Nigeria be planned, to meet the needs, and aspirations of the individual citizen and the needs of society, and ultimately achieve the country's aspirations for National Development? Answer to this question is the main thrust of this paper with regards to the role of the educational planner.

Rationale for Planning Education in Nigeria

Like all other enterprising organizations in human affairs, education in Nigeria must be efficiently planned, and effectively implemented to achieve the objectives, goals and national aspirations of Nigeria. Education is one of the avenues through which national development could be achieved. Bosah

(1991:157) holds this opinion and is shared by many authors in Education. The National policy on education (1998), rates education as 'the most important instrument of change'. Most world countries use education as an instrument to plan national development. The potency of education as a change agent, is manifested in its effect on socialization, the transmission of culture, acquisition of skills, knowledge and societal norms as well as inculcating moral values and attitudes (Bosah 1991:157). This explains why education should be properly planned and effectively implemented.

All modern nations and developing ones including Nigeria, have confidence in the rewarding benefits of education. This is why Educational planning has been defined by Bosah (1991:157) as the process of determining in advance what you want to do in the field of education, and how you are going to do it to achieve productive gains such as those enumerated in paragraph one above. The roles of the educational planner in a result-oriented planning, presenting prescriptions or imperatives in planning, that will result in achieving goals, and national aspirations in educational enterprise in Nigeria maybe examined under the following sub-headings:

i. National targets/aspirations
ii. Challenges and problems of Educational planning
iii. Result-oriented planning
iv. Planning imperatives for the achievement of goals in education
v. Areas to be covered in planning education
vi. Consideration for levels of education in Nigeria

National Targets

The planner has two targets to consider.
Firstly, the needs of the individual citizen (the learner) and the needs of the society. The needs of the individual citizen in the country are paramount when one is considering educational planning. When the individual citizen is properly educated, he/she becomes an asset to the country. With the acquired knowledge, skills, and creativity, he/she can contribute to the development of society and the nation. This explains why the individual citizen should be given education to the best of their abilities and potential. In planning education for Nigeria, due consideration must be given to the individual learner and the society (the Nigerian Nation) i.e. what you want it to be, is what will lead it to get there. Planning based on these two targets is imperative, if goals of education in Nigeria must be achieved.

Secondly, the nation (Nigeria) is another target for serious consideration when planning education. Nigeria is ambitious to attain national development to be counted among the developed countries of the world. Thus, when planning education for Nigeria, focus must be directed towards those things that have caused other countries e.g. U.S.A. to become developed and those things which can make Nigeria to become a developed country, given all the natural endowments and abundant human and material resources at its disposal.

Education in Nigeria must be planned to harness these available resources to get Nigeria developed to join the club of developed nations of the world.

In planning education, consideration must be given to the need to wipe out illiteracy in Nigeria, help to improve the quality of life, and help to acquire the ability to reason wisely and constructively. Planning must give attention to the fragile nature of the Nigerian nation, by emphasizing national integration and national unity when planning education. Ozigi & Canhan (1977) observed that, this is very necessary if the fragile nation (Nigeria) is to be kept united. Educational planning is diverse in scope, hence, the planner he has a lot of work to do, to plan education to suit the Nigerian culture and background, which were ignored by colonial educationists. Consequently, the planner is starting from a new slate. Thus, the planner is confronted with numerous challenges and problems as discussed below:

Challenges/Problems of Educational Planning

The educational planner is confronted with the following national challenges which he must contend with and take them into consideration when planning education for Nigeria. They include among others, the following:

1. Emerging times and emerging changes

Changing times come, and go; changes emerge and require planning to match. To live in the past or believe that colonial educational structures were best for Nigeria, is to lag behind and stagnate. Educational planning confronts new times, new problems, new ideas, new changes and new awareness and new answers to changes. The planner must be aware of this and act in accordingly when planning education for Nigeria.

2. Consideration of the Duration of Production of Educational Personnel

The educational planner is faced with the problem of planning for teachers of the right calibre (trained teachers) medical doctors, civil engineers, mathematicians, agriculturists etc. It takes several years to produce these calibre of personnel who are relevant for national development. There must be a provision of appropriate educational institutions to produce and provide these enumerated essential personnel in the right quantity and quality to harness the economy for national development. This is the responsibility of the planner to handle. Colonial masters ignored this provision; Nigerian planners should not ignore this essential target.

3. Consideration of Proper Allocation of the scarce Economic Resources

The planner cannot plan using pebbles or counting sticks. His planning is based on allocation of scare resources – money and highly qualified trained minds. Educational expenditure competes with other sectors of the economy namely: health, social services, agriculture, commerce and industries and others, in the national budget. The planner must make room for certain educational programmes which are more urgent and curtail those deemed less urgent. This requires discreet action and tact,

but with full explanation, in order not to hurt interests, politicians, individuals, groups or communities concerned in the programmes.

4. **Consideration of the Nature of the Nigerian Society:**
   The educational planner has to contend with Nigerian society. The society is complex and heterogeneous. With literate and illiterate people, political, social, economic and ethnic interests confronting the planner. To achieve the national goals, there must be understanding. Understanding of the National goals, calls for a co-operative endevour for a common federal plan on education e.g. the 6-3-3-4 year educational system, (1977), was nationally oriented. It enhances the sense of unity and common purpose and stimulates acceptability but, when such a programme is sectional, and designed to benefit one area or region, it becomes unacceptable. Nomadic education in the north must be balanced with fishing-ports-education in the south to make both acceptable. Planning must be done to take care of the two interests.

5. **Consideration of Wastage Arising from Incompetency:**
   The planner faces duplication of educational programmes and institutions. It is cost-saving to concentrate school of technology in a definite center, school of medicine in another, agriculture in another etc. It is not advantageous to duplicate schools and programmes. For example there are too many grammar schools in Nigeria, producing mostly, art-oriented personnel at the expense of science and technical personnel. The planner has to contend with this imbalance and tilt the balance to fifty-fifty level base.

Result-oriented Planning: What the Educational Planner is Expected to do in Educational Planning for Nigeria

The Nigerian educational planner is expected to embark on planning education for Nigeria in the following areas as advocated by Ezeocha (1991). Providing for intelligent set of goals with political, social, economic, health and moral orientation and other e.g.

- Political goals would emphasizes national integration, patriotism and selflessness giving priority to the nation first, before self. e.g. Nigeria first, before Tom.
- Social goals would emphasize the mixing up of youths of Nigeria in sports and games and national youth service corps as is being practiced now.
- Economic goals would emphasize the development of economic resources of Nigeria as products for economic development e.g. crude oil, solid minerals and agricultural products.
- Health goals would emphasize men sana incorporate sane. A healthy mind in a healthy body.
- Moral goals would emphasize ethnical practices to maintain a sane society.

- Providing for Manpower Development: Every educational planner must appreciate that, high level manpower is essential for economic development of a nation. It is therefore the duty of educational system. The production and provision of manpower for the classrooms must be adequate and appropriate i.e. the quantity must be adequate and the quality must be high and appropriate. Manpower/personnel required in education must be suitable to serve the purposes and requirements for the different categories and levels of education to provide high level manpower for all sectors of the nation's economy.

Creating room for information or data collection on available skills and manpower resources, wastage, unused surpluses of labour, untrained personnel, sources of external assistance/and, to education, traditional/cultural, religious barriers requiring modernization should be considered in educational planning to avoid hitches during implementation of the plans. Room must be created for weighing the relevance of alternatives e.g.:

a. Existing formal school programmes or another option

b. The new formal school programmes or any other programme

c. Sponsored programmes by industries or by the public

d. On-the-job training or skill acquisition training

e. Adult education programmes to wipe out illiteracy or compulsory education for all

f. Curricula – what type of curriculum is best suited for Nigeria.

The planner should provide for balancing between urgent/important and less urgent programmes. This requires making hard choices and assigning priorities to different levels of education making hard choices and considering them in sequential phases for implementation of the plan.

- The planner should plan for regular flow of ideas and make room for expansion as need arises and make allowances for alterations of planned programmes during reviews of the plans, as experienced during implementation.
- The planner should provide for frequent evaluation and systematic review to discover new problems and insert new goals into the planned programmes.
- Sources of financial support needed for the stages and aspects of the plans must be indicated. A planner is usually asked: Did you provide for these enumerated criteria of planning? They (planners) must adequately provide for some of these criteria, if they cannot provide for all.

Planning Imperatives for the Achievement Goals in Education

The educational planner should avoid the following:

a. Quantity should not be taken for quality and vice versa, in view of so many things to be done in education, each has its own merit.

b. Both quality and quantity must be planned for. The planner should indicate what should be done first as against what should be done later. Priority attention should be given to the more urgent and important pressures. (Ezeocha 1991).
c. Wisdom in decision making about value judgement is necessary. Weigh the demands of the economy, the social well-being of individuals and political necessities and make a decision based on weight/pressure.
d. Educational planners are to be courageous and have the will to take bold decisions on educational matters instead of feeling timid or frightened about what is involved in the plan.
e. Educational planners should consider quantity and quality, as relevant equals and place them at par during planning and not to consider one more important than the other. To do this is to meet hitches during implementation.
f. Planners should plan education to suit national interests and regional/state and local interests by adapting the plans to suit local needs to serve as compliment to national needs.

Areas to be covered in Planning Education
Education has been recognized as a positive change agent. Nigeria has great faith and confidence in it to do 'miracle', for her as it has done in advanced countries of the world. When the planner undertakes planning, he should take into account of Nigerian cultural background, the economic, social, political and moral factors. These considerations are discussed below.

The Nigerian Society
Nigeria is made up of 150 nations or ethnic groups, but for convenience, it is now grouped into three major regional groupings: Hausa – Fulani in the north with minor ethnic groups e.g. the Gwaris in between them, with many traditional arts and crafts, songs and dances which make them unique as a rural society, Ibos in the east, Yoruba in the west. The planner must plan education to reflect Nigeria's cultural heritage. He has not started planning if he fails to include this essential aspect of planning. (Ezeocha, (1991) posits that "no educational policy of Nigeria …can be complete, without giving full encouragement to our cultural heritage". Nigeria is now split into 6 geopolitical zones. Education planners must consider these zones.

Consideration of the Nigerian Economy:
The planner is compelled to study and get a good grip of Nigerian economy to enable him balance is planning job. Nigeria depends on oil economy and agricultural products as secondary income earner. Both oil and agriculture yield revenue for her economic sustenance and survival. With revenue from oil and agriculture, Nigeria is investing and embarking on industrialization (technological turn around). The educational planner should plan education which is tilted toward technological transformation, planning should be done by preparing young Nigerians to handle technical aspects of the modernizing economy instead of employing expatriates to work for Nigeria at very high pay.

Political Consideration

Planners of education should regard political consideration as imperative because Nigeria is regarded as an artificial creations as a result of amalgamation in 1914. To cement the ties between ethnic groups, education must serve as the factor of integration of the several ethnic groups. That apart, the contradictions, ambiguities and lack of uniformity in the educational systems brought about by missionary bodies in 1850s should be removed to ensure an even uniform and orderly development of the country. Uniformity in educational system is the answer to orderly development of the country. States which are still educationally disadvantaged should be provided for in planning to catch up fast with the educationally advantaged states through enlightenment campaigns, free education, legislation against early marriage, prevention of dropout of school etc. Although instability in Nigerian political history has affected, the work of planners, through change in government, yet, with the new political structure of democracy, replacing military regimes in Nigeria 9May 29, 1999), there is hope for educational planners in Nigeria to engage on enduring educational planning for Nigeria.

Consideration of Culture: Language

English is a foreign language used in Nigeria. To emphasize independence in Nigeria, the teaching of indigenous languages is emphasized. It is impossible to reflect 150 languages in the syllabus as languages of learning in schools. It is therefore sound to restrict the learning of indigenous languages to three: Hausa, Yoruba and Ibo. In planning for language education, three of these languages should be made compulsory but studying at least one of them or all three in schools in addition to English is emphasized.

Religious Consideration

The planner has to consider religious and moral education as important prescription to build an ethnical and moral society. The planner should plan education to reflect this subject 'to produce an educated person of sound and religious background' Ezeocha (1991:139).

Consideration of the Levels of Education in Nigeria

The educational planner plans the following levels of education in Nigeria.

1. Pre-Primary Education: This is education for children of 3 – 5 years of age.
2. Primary Education: This education is given to children of 6 – 11 years' old. It is free and universal.
3. Secondary Education: This education is given to children who have completed primary school. It prepares children to enter university or work for useful living.
4. Higher Education: This education includes Universities, Polytechnic, Colleges of Technology, Advanced Teacher – Training Colleges. It is for brilliant secondary school leavers who go in through Joint Admission and Matriculation Board Examination. In the Universities, teaching, research and publication are emphasized. The planner also plans for technical education, special education, teacher education, and adult education.

Recommendations for a Result-oriented Planning of Education in Nigeria

In making suggestions for improvement in educational planning, the following recommendations are proposed:

1. Planning – change is the emphasis. During missionary and colonial educational system, note learning (memory work was emphasized). A child was forced to learn all subjects of the school curriculum, whether it fits his intellectual capacities or not. This paper emphasizes change as a remedy for improvement in planning. The child should learn subjects, skills and programmes best suited to his abilities, and at the rate which they are capable. Although, core subjects are emphasized in education, there should be no attempt to enforce compulsory choice of subjects. Subjects should be chosen based on the changing times, considering the arrival of computer technology and automation (press button technique) into educational system.
2. Funding of education, should be handled by the Federal Government throughout the country because education is a single instrument to change Nigeria technologically. That is why education should be funded by Federal Government and make sufficient budgetary allocation to educational planning to ease planning, which results in achieving educational objectives and national goals.
3. Professional personnel in education should be placed in National planning board to advise national planners on the best way education should be planned to yield dividends for the country in terms of achieving national goals and development.
4. Refresher courses should be regularly mounted to update planner's technical skills on planning.
5. Institutions which train teachers should incorporate planning programmes as electives to equip teachers with the skill of educational planning. This will in turn improve planning education in schools.
6. Administration of educational institutions should emphasizes conscious implementation of planned programmes. Schools administrators themselves should be planning agents and should train teachers to become planners. Planners of education should participate in the overall national planning. In fact, they should lead in national planning. They should give their expert advice during the exercise of development plans for the country.

Conclusion

Educational planning is undergoing changes, from colonial (1850s – 1950s0 to indigenous planning from 1970 – 2000 and so on. What is required of the planner is to base his planning on change, and the circumstances of the time,

bearing in mind technological changes that influence society and its well being in the present age of automation.

Thus, every planning step taken by the planner should be guided and based on the changing circumstances of our time. The educational planner must be watchful and keep tract with trends and movement of the times and events, to enable him plan properly and keep abreast with times and circumstances.

The educational planner is aiming at quantitative and qualitative goals. If this is his avowed target, he must embark on short-term training, medium term planning, and long term planning, and watch their implementation successes, and review where necessary, so that when defects are revealed, they should be corrected without delay. Education being a change agent, it must be we planned and effectively implemented to reap its fruits.

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A Survey of Perceived Hindrances to Junior Secondary School Science Teaching

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Abstract

This study investigated situations which Junior Secondary Schools (JSS) teachers perceived as hindrances to their teaching functions. A 30-item questionnaire with a 5-point scale was used to collect data from 116 science teachers who taught in private and public schools. The schools were based in rural and urban settings. An examination of the rank ordered hindrances showed that large class sizes, heavy teaching load, lack of funds to purchase materials and inadequate treatment of certain topics in the pupils' textbooks hindered JSS science teachers the most. It was also found that different percentages of teachers perceived each of the situations (the main instrument described) as a serious hindrance. The percentages varied from 68.1 (heavy teaching load) to 14.6 (lack of knowledge in biology). Statistical analysis of the data using the z-test for 2-sample cases showed no significant difference between the hindrances perceived by three compared groups of teachers namely, teachers in rural and urban schools, teachers in private and public schools and teachers who specialised in science and their colleagues who did not. A significant difference was however found between the hindrances perceived by male and female teachers. One major finding of the study is that due to the lack of science teachers in the public schools, teachers who taught other non-science subjects such as Cultural Studies, Life Skills, Social Studies and English Language were assigned to teach science.

Introduction

The need for a purposeful educational system coupled with the general dissatisfaction with the unproductive system of education bequeathed to Ghana by the colonial government resulted in the development of the New Educational Reform Programme. The nationwide implementation of the JSS programme in September, 1987 is part of the reform package for Basic Education. The inclusion of science in the JSS curriculum was meant to meet the needs of society and further education while providing an appropriate science education for the JSS pupils (CRDD, 2001).

The curriculum materials that were developed to ensure the smooth take-off of the JSS science programme included a syllabus, pupils' textbooks and teachers' handbooks. Science kit boxes were also provided to supplement the science teaching and learning materials schools were to buy, collect, improvise or grow for use (MOE, 1986, P. 41).

In an attempt to strengthen the capability of JSS science teachers to cope with certain role expectations under the Reform Programme, intensive training of trainers courses were organised for selected teachers at the Kumasi Technical Institute in January, 1990. These teachers were expected to organise similar

courses for JSS science teachers in various Educational Directorates and Zones in the country (Nyavor and Oppong, 1990). Prior to this exercise, some teachers had been transferred from the then Middle Schools to Primary Schools. The aim of this exercise was to produce a crop of teachers whose training and experience measured up to the standard expected of JSS teachers.

In spite of the measures the Ghana Education Service (GES) put in place to ensure the success of the JSS science programme many stakeholders complained that its implementation was being rushed. They cited the lack of science teachers, poor infrastructure facilities, low teacher moral and output and the low academic performance of the pupils as problems that should have been tackled head-on.

When the science results of the first batch of JSS pupils at the Basic Education Certificate Examination (BECE) were released in 1990, many science educationists noted that shocking as the results were, they were indicative of serious structural problems with the entire JSS programme.

Commenting on the performance of the first batch of JSS pupils in science at the BECE, the Chief Examiner wrote that the candidates' performance was generally poor and that they were unable to understand the questions (WAEC, 1990, p. 11). Similar comments were made by the Chief Examiner in his 1991 Report. He noted that the majority of the candidates produced answers, which showed that they only had hazy ideas of what was demanded by the questions (WAEC, 1999; p. 39).

Although there appeared to be slight improvements in the candidates' performance in subsequent years, the overall output has not matched expectations. One recurring feature in the Chief Examiner's Reports is the extensive write-up about the candidates' weaknesses as against their strengths. Weaknesses reported on included the candidates' apparent lack of understanding of simple scientific concepts, the unsystematic presentation of calculations, spelling mistakes, wrong labellings and superficial answers. To the BECE Science Chief Examiner, most JSS science teachers taught the subject without practical activities and also seemed to teach only aspects of the syllabus they could conveniently handle.

It is noteworthy that apart from isolated cases of complaints from JSS Science teachers as to the conditions under which they worked, no national attempt had been made to collate the views of the teachers on various aspects of the JSS science programme. Although such a venture is likely to be costly, it is nonetheless a very credible approach to determining whether or not the JSS science programme is on course. There is some evidence that whenever educational authorities failed to devote time and effort to the concerns of teachers, ill feelings developed, resulting in the teachers' refusal to be drawn away from their conventional classroom techniques (Kelly, 1983). Such situations have adverse effects on the intended programme outcomes. If the JSS science programme is to serve the purpose for which it was initiated, then the teachers' views should be tapped to add to the pool of detailed information required to guide implementation.

Review of Literature

The JSS science programme has attracted considerable attention from educational researchers. One of the earliest attempts to evaluate certain aspects of the programme was Omari's (1981) study. He focused his attention on science teaching strategies teachers used and found that practical activities were hardly organised by the observed teachers. He, however, stopped short of finding out the science teaching constraints in the Experimental Junior Secondary schools (EXJUSSs) he studied.

In a similar study on the EXJUSSs, Dzebu (1987) focused on only one JSS at Tsito. He found that the school lacked science teaching and learning materials and that the teacher did not utilise the prescribed teaching approaches. A detailed investigation of the local constraints to science teaching was however not carried out. The results of such an investigation would have been instructive as to the steps the designers of the science curriculum of the EXJUSSs could take to solve some of the implementation problems. Tufuor (1989) on his part investigated the implementation of the JSS science programme in Cape Coast District and discovered a number of problems. Notable among the implementation problems were the pupils' weak background in Science and English, the extensive nature of the science syllabus and the lack of furniture and laboratories. Other critical areas of the programme such as the availability of curriculum materials, the adequacy of the contents of the available textual materials, the teachers' knowledge of the subject matter etc. were not investigated.

Yabom (1998) surveyed the available science teaching and learning materials in selected schools in the Tamale Metropolis and found educational provisions in the schools to be very poor. The science teachers were however not asked about problems they perceived as hindrances to their work at school. Consequently, the suggestions Yabom made towards improved teacher performance in the schools centred on science teaching and learning materials only.

A search of the available literature showed that about 20 years ago, Amartey (1981) designed a study to investigate the implementation problems of the Project for Science Integration (PSI). The PSI was meant to replace the then General Science Course and was initially trial-tested in five Secondary Schools (Achimota, Nungua, St. John's Grammar, Ghanatta and Mfantsipim). Amartey generated 27 implementation problems and mailed them to science teachers in schools that were implementing the PSI. The questionnaire items covered five main areas, namely the Methods, Preparation, Departmental and Administrative Problems and Problems in relation to students. He found that the teachers encountered problems in the five areas to varying degrees. Amartey concluded his study by giving suggestions as to how teachers could solve the problems they reported. It was obvious that since the teachers indicated the specific problems they encountered, they were more willing to test the workability of the suggested solutions.

Among the actions the GES had previously taken to solve some of the implementation problems of the JSS science programme was the organisation of courses that focused on the prescribed curriculum materials. The courses

were ultimately aimed at improving the capabilities of the JSS science teachers. It should however be noted that no needs assessment was conducted before the courses were organised. The tacit assumption was that the GES officials knew what was good for the teachers. Since the teachers are implementers of the JSS science curriculum at the classroom level, their views should be considered before remedial actions are taken. This study was designed to increase the pool of data required to plan appropriate interventions to ensure the achievement of the intended outcomes of the JSS science programme.

Purpose

The purpose of the study was to determine the extent to which various situations in the schools hindered JSS science teachers from performing their teaching functions effectively.

Null Hypotheses

The following null hypotheses were formulated and tested in the study.

1. There will be no significant difference between the hindrances to JSS science teaching perceived by male and female teachers.
2. There will be no significant difference between the hindrances to JSS science teaching perceived by teachers in rural and urban schools.
3. There will be no significant difference between the hindrances to JSS science teaching perceived by teachers in public and private schools.
4. There will be no significant difference between the hindrances to JSS science teaching perceived by science specialised and non-science specialised teachers.

Research Design

The survey design was adopted in this study. This was to enable the researcher to sample the views of a wide variety of teachers on the problems they encountered as they implemented the JSS science programme at the classroom level.

Population

The target population for the study consisted of all JSS science teachers in the country. Due to the researcher's desire to sample the views of a wide cross-section of teachers, Patton's (1990) maximum variety sampling technique was utilised in the selection of the research subjects. Consequently, a countrywide selection was made comprising teachers in Private and Public Schools, teachers in rural and urban schools and male and female teachers. The researcher's intention in selecting a heterogeneous sample was to enable him to determine the commonalities or otherwise of their experiences.

Instrument

The main instrument used in the study was the Hindrances Assessment Schedule (HAS), which was developed by the researcher and contained 30

items. In order to generate valid items for the HAS, a random selection of JSS science teachers and some experienced educationists were asked to indicate their concerns about the JSS science programme. The list was eventually reduced to 30 items.

To ensure the content validity of the instrument the items in it were compared to implementation instructions in the JSS science teacher's handbooks, the science syllabus and official documents on the programme.

Using Pearson's correlation formula a reliability index of 0.912 was calculated for the instrument based on the test re-test procedure. Before being used for the main study the instrument was pilot-tested with 20 JSS science teachers in the Winneba District.

The final version of the instrument was divided into two sections. The first section was designed to collect biographical data. The second section contained 30 items that described situations JSS science teachers were likely to perceive as hindrances to their teaching functions. The teachers were required to indicate the intensity of their responses to each item on a 5 – point scale as A – Very Serious Hindrance, B – Serious Hindrance, C – Moderate Hindrance, D – Slight Hindrance and E – No Hindrance, Starting from A through to E, the responses were to be scored from 5 to 1.

Data Collection

Before the questionnaire was administered the researcher arbitrarily divided the country into three zones – the Southern Zone (Greater Accra, Western and Central Regions), the Middle Zone (Ashanti, Eastern, Volta and Brong Ahafo Regions) and the Northern Zone (Northern, Upper West and Upper East Regions). With the help of student research assistants, 200 questionnaires were distributed in the three zones to various categories of JSS science teachers. One hundred and sixteen (116) usable responses were received over a two-month period. This represented a return rate of 58%. This figure compares favourably with a return rate of 36.7% for Easter day and Smith (1992) and a 42.6% return rate for Baird and Rowsey (1989) in similar studies.

Results

The response rate for each item in the HAS was 100%. The item mean response score (IMRS) for each item in the HAS was computed from all the responses for each item. The score for "No Hindrance" was excluded from the calculations. The standard deviations were also calculated. The results have been summarised in Table 1.

Table 1 Rank Ordered Hindrances by Score

Rank	Hindrance/Situation	Score	Item No.	S.D.
1.	Large class sizes	4.02	28	1.19
2.	Heavy teaching load	3.97	29	1.29
3.	Lack of funds to purchase materials	3.95	2	1.15
4.	Inadequate treatment of some topics	3.85	12	1.20
5.	Teaching interrupted by external activities	3.83	24	1.53
6.	Wide syllabus	3.76	15	1.21
7.	Negative attitude of the pupils	3.73	26	1.26
8.	Insufficient periods	3.70	16	1.14
9.	Lack of in-service training	3.65	20	1.31
10.	Poor academic ability of the pupils	3.63	27	1.35
11.	Some topics are not in the JSS textbooks	3.62	11	1.48
12.	Some BECE questions are irrelevant	3.56	13	1.25
13.	Insufficient equipment and materials	3.55	1	1.18
14.	Teachers' guides not available	3.50	6	1.33
15.	Too many administrative responsibilities	3.47	30	1.37
16.	Insufficient textbooks	3.44	8	1.19
17.	Teaching interrupted by internal activities	3.35	25	1.25
18.	Science syllabus not available	3.26	7	1.42
19.	Lack of knowledge in chemistry	3.21	18	1.24
20.	Lack of knowledge in physics	3.16	19	1.24
21.	Unco-operative attitude of the community	3.14	22	1.39
22.	Improper topic sequencing in syllabus	3.14	14	1.32
23.	Syllabus not always specific	3.11	10	1.22
24.	Difficulty in improvisation of materials	3.09	4	1.48
25.	Unco-operative attitude of headteacher	3.07	23	1.35
26.	The course is full of activities	3.01	9	1.30
27.	Strict rules on the use of materials	2.99	3	1.44
28.	Lack of Knowledge in biology	2.98	17	1.16
29.	Lack of knowledge in the use of some materials	2.95	5	1.37
30.	Unco-operative attitude of colleagues	2.84	21	1.48

Overall Mean Score = 3.42
Overall Sandard Deviation = 1.31

In order to gain an insight into the proportion of teachers who felt seriously hindered by the situations described by the instrument, the categories of 'Very Serious Hindrance" and "Serious Hindrance" were collapsed into a single category of "Serious Hindrance". Using this new category, the percentage of teachers who felt seriously hindered by each of the situations described by the items in the main instrument, was calculated. The results have been summarised in Table 2.

Table 2 Percentage of Teachers Who Felt Seriously Hindered

Rank	Hindrance/Situation	% of teachers
1.	Heavy teaching load	68.1
2.	Inadequate treatment of some topics	62.1
3.	Wide syllabus	61.2
4.	Lack of funds to purchase materials	60.3
5.	Large class sizes	59.5
6.	Teaching interrupted by external activities	53.4
7.	Insufficient periods	52.6
8.	Poor academic ability of the pupils	52.6
9.	Some BECE questions are irrelevant	49.1
10.	Lack of in-service training	49.1
11.	Some topics are not in the JSS textbooks	48.3
12.	Insufficient equipment and materials	48.2
13.	Too many administrative responsibilities	41.4
14.	Teachers' guides not available	38.8
15.	Teaching interrupted by internal activities	34.5
16.	Insufficient textbooks	32.8
17.	Negative attitude of the pupils	31.0
18.	Unco-operative attitude of the community	29.3
19.	Difficulty in improvisation	28.4
20.	Syllabus not always specific	27.6
21.	Improper topic sequencing in syllabus	23.3
22.	Unco-operative headteacher	20.7
23.	The course is full of activities	19.0
24.	Lack of knowledge in chemistry	19.0
25.	Lack of knowledge in physics	19.0
26.	Strict rules on the use of materials	18.1
27.	Science syllabus not available	18.1
28.	Unco-operative colleagues	16.3
29.	Lack of knowledge in the use of some materials	14.6
30.	Lack of knowledge in biology	14.6

Average % = 36.0

The classification of the teachers into male/female, trained/untrained, urban/rural etc. based on a total of 116 teachers is shown in Table 3. The criteria used for the classification were the sex of the teachers, the setting of the schools, the professional status of the teachers, the type of schools and the subject specialisation of the teachers.

Table 3 Classification of the teachers

Sex		School Setting		School type		Status		Specialisation	
Female	Male	Urban	Rural	Public	Private	Trained	Untrained	Science	Non-science
22	94	58	58	99	17	99	17	92	24

It was found that there was a disproportionate number of untrained teachers in the private schools compared to those in the public schools. The qualifications of the teachers in the public land private schools are shown in Table 4.

Table 4: Qualification of the Teachers

Qualification	Number of Teachers	
	Public Schools	Private Schools
"O" Level	1	-
"A" Level	6	8
Cert "A" (4-Year)	1	-
Cert "A" (2-Year Post-Sec)	7	-
Cert "A" (3-Year Post-Sec)	70	7
Specialist	7	-
Diploma	7	1
B.A./B.Sc.	-	1*
Total	99	17

Hypotheses Testing

Statistical analysis of the data was done using four parametric tests. Because of the large number (116) of research subjects involved, the Z-test for 2-sample cases was used to test the significances between the hindrances perceived by different groups of teachers. The groups considered were the urban and rural school teachers, male and female teachers, trained and untrained teachers, private schools and public school teachers and non-science specialised and science specialised teachers.

The only difference that was found to be statistically significant was that between the hindrances perceived by male and female teachers. The results have been summarised in Table 5.

Table 5: Summary Z-Test Results

Groups Compared	Numbers of Teachers	Mean	S.D.	Z-Value
Rural school teachers	58	2.818	0.609	1.479*
Urban school teachers	58	2.745	0.605	
Female teachers	22	2.822	0.588	2.701**
Male teachers	94	3.20	0.618	
Private school teachers	17	2.792	0.690	0.242*
Public school teachers	99	2.835	0.598	
Science specialised teachers	92	2.765	0.707	0.390*
Non-science specialised teachers	24	2.831	0.611	

*Not significant Z-test = 1.96 P<0.05
**Significant

Discussion

The major purpose of this study was to determine the extent to which various situations in the schools hindered JSS science teachers in their teaching functions. An examination of the ranked hindrances in Table 1 shows that on the whole, the teachers were most hindered by school-specific situations (large class sizes, heavy teaching loads and the lack of funds to purchase materials). The inadequate treatment of some topics in the JSS textbooks, the interruption of teaching by external activities and the extensive nature of the JSS science syllabus also hindered the teachers to an appreciable extent. Since these three situations originated from outside the school, they affected all the teachers and were thus likely to have adverse effects on the performance of the teachers as a whole. While headteachers and teachers could take steps (at the local level) to solve school-specific problems such as heavy teaching loads, there appeared to be very little they could do to solve problems connected, for example, with inappropriate curriculum materials.

One other significant finding was the lack of in-service training courses which 49.1% of the teachers reported as a serious hindrance. This area is critical to the teachers' professional competence since they are to keep abreast with current science teaching and learning approaches and issues. Indeed a high proportion of the situations the JSS science teacher perceived as serious hindrances could have been rectified had regular in-service trainings been organised for the teachers (Becker & De Guire, 1983).

It was found that even when in-service training programmes were organised science teachers from the private schools were excluded. This practice is a serious set-back for science education in the country in that a high proportion of the JSS science teachers in the private schools are untrained. In the present study, 9 (53%) of the 17 JSS science teachers in the private schools were untrained. One of the untrained teachers held a B.A. (Linguistics) degree while

the rest were “A” Level holders. As Cobbinah (1996) noted, untrained teachers added to the learning problems of the JSS pupils instead of solving them.

It appears that since the Ministry of Education (MOE) supplied science kit boxes to the schools at the inception of the JSS science programme, no serious attempt has been made to augment the teaching and learning materials in the schools. Many teachers thus felt hindered by the lack of teaching and learning materials and were sometimes forced to adopt literary approaches to science teaching. Abdulahi (1982) has noted that some concepts in science can only be learnt properly through practical activities. In the absence of teaching and learning materials, JSS science teachers automatically revert to traditional didactic teaching (Kelly, 1983) thus making it difficult for the aims of the JSS science programme to be achieved.

The data in Table 1 indicate that the responding teachers found the teaching of chemistry topics in the JSS science syllabus more difficult compared to physics and biology topics. This adds support to the statement by the BECE Science Chief Examiner that the JSS pupils appeared to have problems with questions based on chemistry topics (WAEC, 1992, p. 55).

Since the teachers lacked knowledge in chemistry, they were not likely to treat chemistry topics in the JSS science syllabus adequately. The pupils thus suffered from cognitive deficiencies with respect to chemistry and consequently performed poorly on tests based on chemistry topics. Since the inadequate knowledge of the teachers could have originated from the training colleges (haggis, 1977), the science curriculum of the training colleges ought to be examined and revised if necessary.

A review of the data showed that teachers in both private and public schools were comparable in their perception of “heavy teaching load” as a hindrance to their teaching functions. It is likely that the desire of the proprietors of private schools to maximise profits caused them to increase the workload of the science teachers. As was noted earlier, the increased workload of the public school teachers might be due to the lack of teachers with the appropriate qualifications.

The fact that no significant differences were found in the hindrances perceived by 3 out of the 4 groups of teachers compared shows that the problems JSS science teachers encountered in the field cut across different categories of teachers in the country. This in effect implies that apart from the school specific problems, JSS science teachers faced similar problems at school. This finding agrees with that of Oladimeji (1978) in Bajah (1983). It will thus not be difficult for the Ministry of Education to initiate interventions to solve the problems of JSS science teachers. The most important element in any proposed remedial measure is the promptness with which the activities are initiated. (Conley, 1991). Prompt action should therefore be taken to improve science teaching and learning at the JSS level in order not to cause the teachers to leave the profession out of frustration.

Recommendations

To minimise the frustrations of JSS science teachers in the performance of their teaching functions the following measure are recommended:

1. The Curriculum Research and Development Division (CRDD) unit of the GES should be strengthened to address the concerns of JSS science teachers with respect to the content of the science curriculum materials. This apart, the activities of the CRDD should be decentralised to make the personnel more accessible to JSS science teachers.
2. Personnel at the various science resource centres should be trained to offer support services to JSS science teachers in the districts. The focus of the services could be the organisation of practical activities and the utilisation of innovative science teaching approaches.
3. The GES should encourage JSS science teachers to patronise the activities of the JSS panel of the Ghana Association of Science Teachers (GAST). Regular interactions with their colleagues is likely to expose the teachers to workable strategies they could also adopt to solve some of their school-specific problems.
4. To avoid literary approaches to science teaching and learning only science specialised teachers should be assigned to teach JSS science. Where only non-specialised teachers are available they should be made to undergo complementary training to make up for gaps in their knowledge and skill.

Conclusion

The findings of this study indicate that JSS science teachers are considerably hindered by both school-specific and countrywide situations. Customised approaches (Becher and De Guire, 1983) could be used to solve the school-specific problems based on the unique characteristics of the schools. On the other hand, highly intensive broad-based remediation interventions (Conley, 1991) could be used to solve the countrywide problems encountered by JSS science teachers. A good way to solve teachers' problems is by asking the teachers themselves (Baird, Easterday, Rowsey, & Smith 1993). Since the number of teachers who participated in this study is small, other researchers could replicate the study with larger samples to ensure that a representative number of JSS science teachers express their concerns. These concerns can be used as credible data for future intervention activities to improve the JSS science programme.

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Opportunity to Learn First Year Mathematics in Teacher Training Colleges in Ghana

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Abstract

The purpose of the study was to find out students which of the 18 topics in the first year teacher training mathematics syllabus were not taught by the end of the year and which ones were found difficult. Six hundred and ninety-five second year pre-service teachers, made up of 186 females and 506 males, from 18 teacher-training colleges participated in the study. The study was a cross-sectional survey and data was collected using a questionnaire. An alpha level of 0.05 was used for all statistical tests. The results showed that two topics, measures of central tendency and conditional probability were not taught. It was found that ten of the eighteen topics were found by the students to be difficult to understand. Further results showed that the Arts students found seven topics more difficult than the Science students and female students also found ten topics more difficult than the males. It is recommended that the teacher training college tutors make efforts to complete the PS1 syllabus. Attempts should be made to integrate the discovery approach into teaching and learning difficult mathematics topics. It is further recommended that more tutorials, extra classes and additional assignments should be given to the Arts and female students.

Introduction

Mathematics is one of the compulsory subjects at the first and second cycles of education in Ghana. At the tertiary level also, a pass in Mathematics at the Senior Secondary School Certificate Examination is a requirement for admission.

In the teacher training colleges in Ghana, Mathematics is studied as a compulsory subject in the first and second years. At the end of each of the first two years, final promotion and Part 1 examinations are taken respectively. The syllabus provides for the teaching of content, dealing with the subject matter of Mathematics and methodology aspects that deal with the pedagogical skills of the subject matter.

The first year Mathematics syllabus for the teacher training college was drawn to equip the teacher trainees with the appropriate knowledge and pedagogical skills to make them competent in the teaching of the subject in the teaching field. The choice of the content in the syllabus is based on needs of the trainees and the children they would be expected to teach in the basic schools after their training. The selection was also based on the assumption that the students

had had a sound foundation in mathematics in the basic concepts in the first and second cycles of education. This is supported by the fact that the admission requirements demand at least a pass in Mathematics at the senior secondary school certificate examination. By the end of their three year pre-service programme, the teachers are expected to have a sound knowledge and foundation in mathematics to teach it effectively.

Steinberg, Haymore and Marks (1985), established a positive relationship between the quality of teachers' knowledge of mathematics and the kind and quality of lessons taught in the classroom. Those with greater conceptual understanding used more conceptual teaching strategies, identified relationships inside and outside the mathematics discipline and engaged students in active problem-solving activities. Leinhardt and Smith (1985) further revealed that teachers' lack of exposure to a rich mathematical knowledge base resulted in their inability to make coherent connections among the different topics taught. Grossman et. al. (1992), and Thompson (1992) also observed that how one teaches a subject is influenced greatly by the many ways one understands it. On the basis of this Asiedu-Addo and Yidana (2000) intimated that teachers in the training colleges in Ghana should possess a sound background in pure mathematics.

To obtain the rich mathematical knowledge and a sound background in mathematics, there should be an opportunity to learn (OTL) which includes the scope of mathematics taught, how the mathematics is taught, and the match between students' entry skills and the new material. Studies (Husen, 1967; 1987; Schmidt, McKnight & Raizen, 1997) have shown that strong correlations existed between student OTL scores and mean student achievement scores in mathematics. Baratz-Snowden (1993) believed that if students are held accountable for their learning, schools must be held accountable simultaneously for providing students with the opportunity to learn to meet the standards. Winters et. al., (1994) stated further that opportunity to learn (OTL) often serves as part of the evidence for alternative interpretation of student performance. In this vein, Oakes (1989), and Porter (1991) recommended that school administrators, teachers, and policy makers should not judge test results without considering and analyzing students' opportunity to learn (OTL).

Considering the important role of OTL, it is necessary that school and college authorities provide the resources and materials needed to teach mathematics so that teacher trainees gain adequate content knowledge and professional skills before graduating from the teacher training colleges. Sadly, this appears not to be the case in many countries. Tangretti (1993) found that elementary school teachers in Britain were not adequately prepared to meet the expectations in mathematics instruction. It has also been found in Ghana that the knowledge level of the Ghanaian teachers who teach mathematics is low (Asiedu-Addo and Yidana, 2000).

In acquiring content knowledge and skills in mathematics and the subsequent performance, studies have shown that gender differences do exist. Maccoby and Jacklin (1975) in a ground-breaking study in the United States found that males tended to perform better than females. Fennema and Carpenter (1981) reported that the National Assessment of Educational Progress (NAEP) results in the United States showed boys outperforming girls. Becker et. al (1990) also

reported from a study of 3002 grades 3 through 12 pupils in the United States that boys generally performed better than girls at the upper percentile levels in mathematics problem-solving. Etsey and Snetlzer (1998) conducted a meta-analysis of studies in gender differences in mathematics in the United States and found that boys generally performed better than girls. In the United Kingdom, the Assessment of Performance Unit (APU) reported that at 11 years and beyond, boys perform better than girls. In Ghana, Eshun (1999) found a higher achievement of males than females in the senior secondary school certificate mathematics examination. Wilmot (2001) in a study of primary 3, 4 and 6 pupils observed that statistically significant differences occurred in favour of boys. Criterion-referenced tests conducted by the Ministry of Education for primary 6 pupils in Ghana also showed that the performance of boys was better than girls in mathematics (Quansah, 1996).

In the teacher training colleges in Ghana, very little has been researched and publicly documented on the performance of the students in mathematics though examiners reports have pointed to low performances. The first year promotion examination chief examiners' report of 1999 indicated that a number of topics were found to be posing problems to students due to the lack of understanding of the simple basic principles, theories and concepts underlying those topics. The topics included interpretation of Venn diagrams, number bases, trigonometry and Pythagorean theorem, vectors, and probability. It has not been well researched as to what were the major causes for the students having problems with certain topics. This study attempts to find out students perception of the 18 topics in the PS1 mathematics syllabus. Specifically, an attempt was made to answer the following questions: (a) Which topics in the PS1 syllabus were not taught by the end of the first year? (b) Which topics did students find difficult to understand? (c) What differences exist (if any) among students by the courses they read at senior secondary school in the topics they found difficult? (d) What gender differences exist, (if any) in the perception of the topics taught?

Method

Participants

Six hundred and ninety-five (695) second-year pre-service teachers participated in this study. There were 186 females and 509 males. The pre-service teachers were selected from 18 public teacher-training colleges out of the 38 public teacher-training colleges in the country. The selection of the pre-service teachers was done through a three-stage sampling procedure. The first stage involved randomly selecting seven regions out of the ten regions in Ghana. In the second stage, two public teacher-training colleges in each of the nine selected regions were selected. In regions where there were only two public teacher training colleges, for example, Greater Accra, both of them were taken. However, in the Ashanti and Volta Regions where there were comparatively a large number of teacher training colleges, four colleges were randomly selected from both. The third stage involved randomly selecting one second-year (PS2) class out of the number of second-year classes in each college. All the students in the selected classes constituted the sample.

Research Design

This study is descriptive in nature and designed as a cross-sectional survey that collects information at just one point in time. Surveys serve three main purposes. They make descriptive and explanatory assertions about populations as well as provide a 'search device', when an inquiry is beginning (Babbie, 1990). The main focus in this study was on which topics were not taught, which topics were found difficult, whether any differences exist in students' perception of the topics in terms of gender and courses taken at the senior secondary school levels. To accomplish the objectives of the study, a questionnaire was designed and used to collect data on between December 2002 and March 2003.

Instrument

A two-section questionnaire was developed for the study. Section A requested background information on gender, programme offered in senior secondary school, grade obtained in senior secondary school certificate examination, and their feelings towards mathematics teaching. Section two lists the topics in the first year mathematics syllabus and participants were instructed to indicate whether each topic was taught and whether the topic was difficult or easy to understand. The instrument as a whole had a Cronbach's alpha of 0.686 as the estimate of its reliability. Section B which contains information pertaining to this study had a Cronbach's alpha of 0.838. Content validity was achieved through reviews and revisions of the draft questionnaire before and after a pilot study. Final year students and a lecturer in educational measurement and statistics from the Department of Educational Foundations, University of Cape Coast designed and validated the instrument.

In the development of the questionnaire, literature on mathematics and the mathematics syllabus for first year students of teacher training colleges in Ghana were first reviewed. A list of items were produced and given to a group of 29 final year (Level 400) students in the Department of Educational Foundations, University of Cape Coast to study and comment on. On the basis

of their comments, the statements were reviewed and a likert-scale was produced and developed into a questionnaire. The questionnaire was administered to the first-year (PS1) pre-service teachers at Kommenda teacher training college in Kommenda, Central Region as a pilot study. The responses to the items were analysed and the final instrument made.

Procedure

Data collection was done in between December 2002 and March 2003. Thirteen teams, each consisting of two or three trained research assistants were sent to the teacher training colleges after permission had been obtained from the principals of the colleges. The questionnaire was completed at one sitting. Instructions were read to the participants and they were given 30 minutes to complete the questionnaire. The participants were assured of anonymity and confidentiality of the responses. For the sake of anonymity, participants were told not to write their names on the questionnaire. It was stressed to them that no one known to them would have access to the results of the study and that their names would not be associated with the results. All the 695 participants returned their questionnaires. After the data had been coded and cleaned, all participants' responses were valid for analysis giving a 100% response rate.

Results

Topics in the PS1 syllabus that were not taught by the end of the previous academic year

All eighteen topics in the PS1 syllabus were listed for students to indicate whether they were taught or not. Majority responses of 50% and above were used as the criteria for acceptance. This implies that where more than half of the class indicated that a topic was not taught, it was accepted as the class decision. The result is presented in Table 1.

Table 1 Status of topics as not taught in PS1 mathematics syllabus

Topic	Total number of responses	% responses for topic not taught
1. Sets	684	2.0 (14)$^{+}$
2. Indices	689	6.5 (45)
3. Number bases	687	7.0 (48)
4. Relations and Functions	683	11.9 (81)
5. Graphs	688	6.3 (43)
6. Algebraic Functions	682	16.0 (109)
7. Solving equations and inequalities	686	4.1 (28)
8. Polygons	687	7.4 (51)
9. Geometric constructions including loci	680	13.1 (89)
10. Circles	685	10.1 (69)
11. Pythagoras Theorem	686	14.6 (100)
12. Movement Geometry	682	36.5 (249)

13. Vectors	687	15.0 (103)
14. Collection and representation of data	689	18.6 (128)
15. Measures of central tendency**	**679**	**56.8 (386)**
16. Probability - Experiments and simple events	688	17.3 (119)
17. Probability – Compound events and tree diagrams	683	45.2 (309)
18. Conditional Probability and Pascal triangle	**677**	**60.7 (411)**

Note. + Numbers in brackets refer to the actual number of responses.
** Topics in bold were not taught.

The results have shown that only two (11%) of the eighteen topics were generally not taught. About 57% responded that Measures of central tendency were not taught while 60.7% responded that Conditional Probability and Pascal triangle was not taught.

Topics which students found difficult to understand

All eighteen topics in the PS1 syllabus were listed for students to indicate which ones they found difficult to understand. The responses ranged from very difficult (1), difficult (2), easy (3) and very easy (4). The percentage responses were those who selected very difficult and difficult from the four options. The lower quartile, (i.e. 25% of the respondents) and above were used as the criteria for acceptance of difficulty. In the ideal classroom, teachers expect that all (100%) of the students understand each topic taught. However, several factors such as previous knowledge, illness, attitude, educational background and teaching learning resources, affect the comprehension ability of each student. It was on this basis that a lower quartile was used as the criterion. This implies that where more than 25% of the class indicated the topic was difficult to understand, it was accepted as the class decision. The result is presented in Table 2.

Table 2 Difficulty status of PS1 mathematics topics

Topic	Total number of responses	% responses on topics found difficult
1. Sets	659	6.8 (45)+
2. Indices	629	19.9 (125)
3. Number bases	618	5.9 (36)
4. Relations and Functions**	591	**33.0 (195)**
5. Graphs	627	12.3 (77)
6. Algebraic Functions	557	**28.4 (158)**
7. Solving equations and inequalities	635	12.6 (80)
8. Polygons	605	16.5 (100)
9. Geometric constructions including loci	569	**27.6 (157)**
10. Circles	584	**40.8 (138)**
11. Pythagoras Theorem	559	23.4 (131)
12. Movement Geometry	396	**43.5 (172)**
13. Vectors	544	**36.8 (200)**

14. Collection and representation of data	541	14.0 (76)
15. Measures of central tendency	298	**33.3 (99)**
16. Probability - Experiments and simple events	539	**42.3 (228)**
17. Probability – Compound events and tree diagrams	366	**52.2 (191)**
18. Conditional Probability and Pascal triangle	267	**57.3 (153)**

Note. $^{+}$ Numbers in brackets refer to the actual number of responses.
** Topics in bold were found difficult to understand.

The results, presented graphically in Figure 1, show that 10 out of the 18 topics were found difficult to understand. The most difficult ones were, Conditional Probability and Pascal triangle (57.3%), and Probability – Compound events and tree diagrams (52.2%). The other topics found difficult were, Movement Geometry (43.5%), Probability – Experiments and simple events (42.3%), Circles (40.8%), Vectors (36.8%), Measures of central tendency (33.3%) and Relations and Functions (33.3%), Algebraic Functions, (28.4%), and Geometric constructions (27.6%).

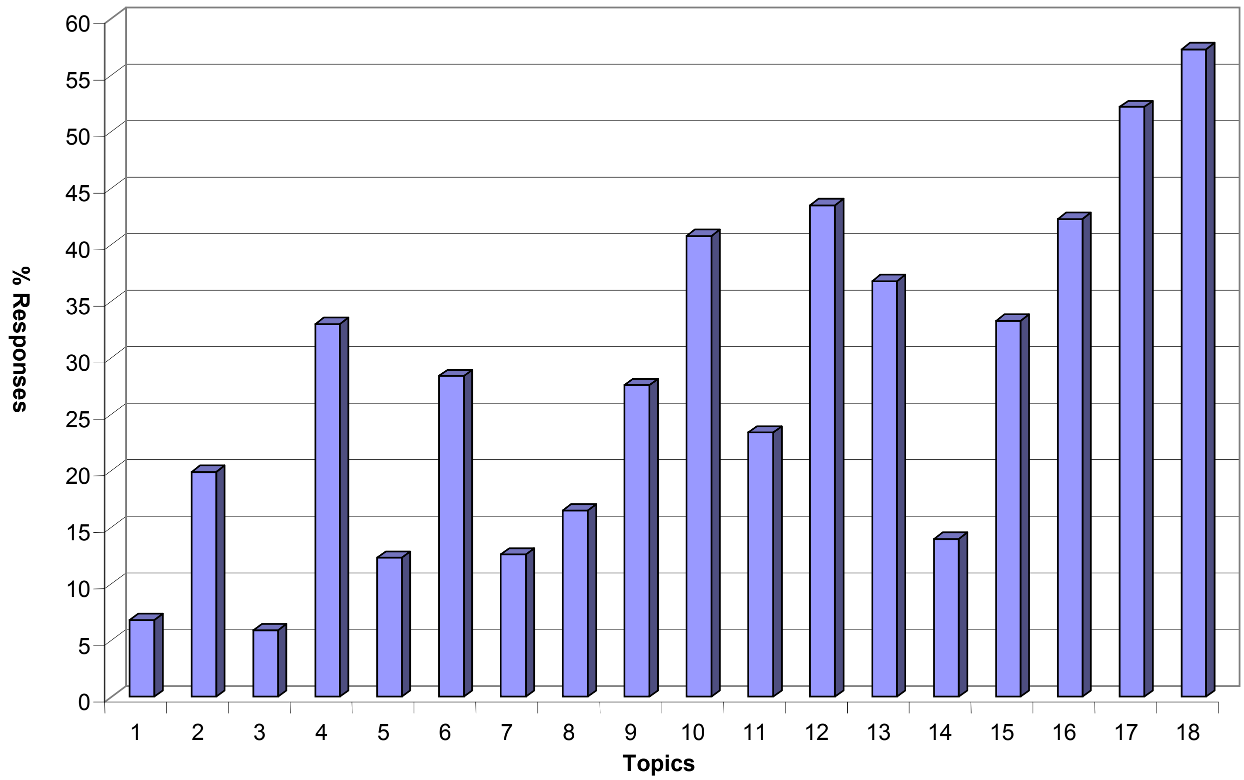

Figure 1 **Difficulty level of PS1 Mathematics topics**

Differences among students in the topics they found difficult by the programmes they read at SSS

Participants entered the training colleges after pursuing different programmes at the senior secondary schools. These programmes were General Arts, Science, Home Economics, Visual Arts, Business, Agriculture, and Technical. For the purposes of this study, since some of the programmes did not have adequate number of students, the programmes were grouped into Arts-based (General Arts, Visual Arts) and Science-based (Agriculture, Science, Technical).

Student responses were selected from four options. These were very easy (4 points), easy (3 points), difficult (2 points) and very difficult (1 point). Significant differences between the Arts and Science students were tested for all the 10 difficult topics using the independent t-test at the 0.05 level of significance. The results are presented in Table 3.

Table 3 Independent t-test for course differences in perception of difficulty of PS1 mathematics topics

Topic	Course	N	Mean	Std. Dev	df	t	p-value
1. Relations and Functions	Arts	301	2.73	0.84	513*	-3.59	**0.000****
	Science	235	2.99	0.80			
2. Algebraic Functions	Arts	279	2.87	0.92	509	-3.28	**0.001**
	Science	232	3.13	0.84			
3. Geometrical constructions including loci	Arts	285	2.94	0.88	514	-0.49	0.627
	Science	231	2.98	0.89			
4. Circles	Arts	290	2.56	0.94	513*	-3.02	**0.003**
	Science	237	2.80	0.90			
5. Movement Geometry	Arts	198	2.49	0.94	347*	-3.17	**0.002**
	Science	158	2.80	0.86			
6. Vectors	Arts	270	2.70	0.91	491	-1.72	0.086
	Science	223	2.84	0.88			
7. Measures of central tendency	Arts	148	2.74	1.03	264*	-2.40	**0.017**
	Science	120	3.03	0.89			
8. Probability - Experiments and simple events	Arts	268	2.58	0.96	480*	-2.33	**0.020**
	Science	221	2.77	0.89			
9. Probability – Compound events and tree diagrams	Arts	181	2.36	0.90	325	-2.00	**0.047**
	Science	146	2.57	0.94			
10. Conditional Probability and Pascal triangle	Arts	123	2.23	0.98	239	-1.24	0.216
	Science	118	2.39	1.05			

Notes. * Levene's test for equality of variances shows variances are not assumed equal.
**Bold p-values are significant at 0.05 level.

Statistically significant differences were found at the 0.05 level for seven of the ten topics. For all the seven topics, the Arts- based students found them more difficult than the Science-based students. The topics are, Relations and Functions ($t(513) = -3.59$, $p < 0.05$), Algebraic Functions (($t(509) = -3.28$, $p < 0.05$), Circles ($t(513) = -3.02$, $p < 0.05$), Movement Geometry ($t(347) = -3.17$, $p < 0.05$), Measures of central tendency ($t(264) = -2.40$, $p < 0.05$), Probability – Experiments and simple events ($t(480) = -2.33$, $p < 0.05$) and probability – Compound events and tree diagrams ($t(325) = -2.00$, $p < 0.05$). No statistically significant differences were found for Geometrical constructions including loci, Vectors, and Conditional Probability and Pascal triangle at the 0.05 level. This latter result implies that both arts and science students found these topics at the same level of difficulty.

Gender differences in the perception of the difficulty of the topics taught

Student responses were selected from four options. These were very easy (4 points), easy (3 points), difficult (2 points) and very difficult (1 point). Significant differences were tested for all eighteen topics in the PS1 syllabus using the independent t-test at the 0.05 level. The result is presented in Table 4 and represented graphically in Figure 2.

Table 4 Independent t-test for gender differences in perceived difficulty for PS1 mathematics topics

Topic	Gender	N	Mean	Std. Dev	df	t	p-value
1. Sets	Female	177	3.35	0.68	657	-1.65	0.099
	Male	482	3.44	0.63			
2. Indices	Female	168	3.01	0.81	627	-2.47	**0.014****
	Male	461	3.19	0.80			
3. Number bases	Female	170	3.36	0.67	616	-2.80	**0.005**
	Male	448	3.52	0.62			
2. Relations and Functions	Female	160	2.61	0.78	589	-4.02	**0.000**
	Male	431	2.92	0.84			
5. Graphs	Female	171	3.09	0.74	625	-2.66	**0.008**
	Male	456	3.25	0.68			
6. Algebraic Functions	Female	149	2.72	0.88	555	-3.89	**0.000**
	Male	408	3.05	0.88			
7. Solving equations and inequalities	Female	176	3.09	0.85	633	-5.03	**0.000**
	Male	459	3.42	0.70			
8. Polygons	Female	166	3.04	0.79	305*	-3.00	**0.003**
	Male	439	3.26	0.81			
9. Geometrical constructions including loci	Female	149	2.83	0.83	567	-2.07	**0.039**
	Male	420	3.01	0.90			
10. Circles	Female	155	2.59	0.80	323*	-1.32	0.187
	Male	429	2.69	0.96			
11. Pythagoras Theorem	Female	155	2.79	0.92	557	-4.60	**0.000**
	Male	404	3.19	0.89			
12. Movement Geometry	Female	101	2.43	0.78	208*	-2.51	**0.013**
	Male	295	2.66	0.95			
13. Vectors	Female	143	2.69	0.85	542	-1.44	0.152
	Male	401	2.81	0.91			
14. Collection and representation of data	Female	147	3.17	0.76	248	-0.60	0.552
	Male	394	3.21	0.72			
15. Measures of central tendency	Female	77	2.81	0.87	296	-0.64	0.520
	Male	221	2.89	0.99			
16. Probability – Experiments and simple events	Female	147	2.54	0.95	537	-1.73	0.084
	Male	392	2.69	0.93			
17. Probability – Compound events and tree diagrams	Female	94	2.44	0.86	364	-0.35	0.730
	Male	272	2.47	0.94			
18. Conditional probability and Pascal triangle	Female	66	2.32	0.95	265	0.137	0.891
	Male	201	2.30	1.03			

Notes. * Levene's test for equality of variances shows variances are not assumed equal.
** Bold p-values are significant at 0.05 level.

Statistically significant differences were found at the 0.05 level for 10 of the 18 topics. For all the 10 topics, the female students found them more difficult than the male students. The topics are, topic 2 - Indices ($\underline{t}(627) = -2.47$, $\underline{p} < 0.05$), topic 3 - Number bases $\underline{t}(616) = -2.80$, $\underline{p} < 0.05$), topic 4 - Relations and Functions ($\underline{t}(589) = -4.02$, $\underline{p} < 0.05$), topic 5 - Graphs, $\underline{t}(625) = -2.66$, $\underline{p} < 0.05$), topic 6 - Algebraic Functions (($\underline{t}(555) = -3.89$, $\underline{p} < 0.05$), topic 7 - Solving equations and inequalities ($\underline{t}(633) = -5.03$, $\underline{p} < 0.05$), topic 8 - Polygons ($\underline{t}(305) = -3.00$, $\underline{p} < 0.05$), topic 9 - Geometrical constructions ($\underline{t}(567) = -2.07$, $\underline{p} < 0.05$), topic – 11 Pythagoras theorem ($\underline{t}(557) = -4.60$, $\underline{p} < 0.05$), and topic 12 -

Movement geometry ($\underline{t}(208) = -2.51$, $\underline{p} < 0.05$). No statistically significant differences were found for the rest of the topics at the 0.05 level. This latter result implies that both female and male students equally found these topics at the same level of difficulty.

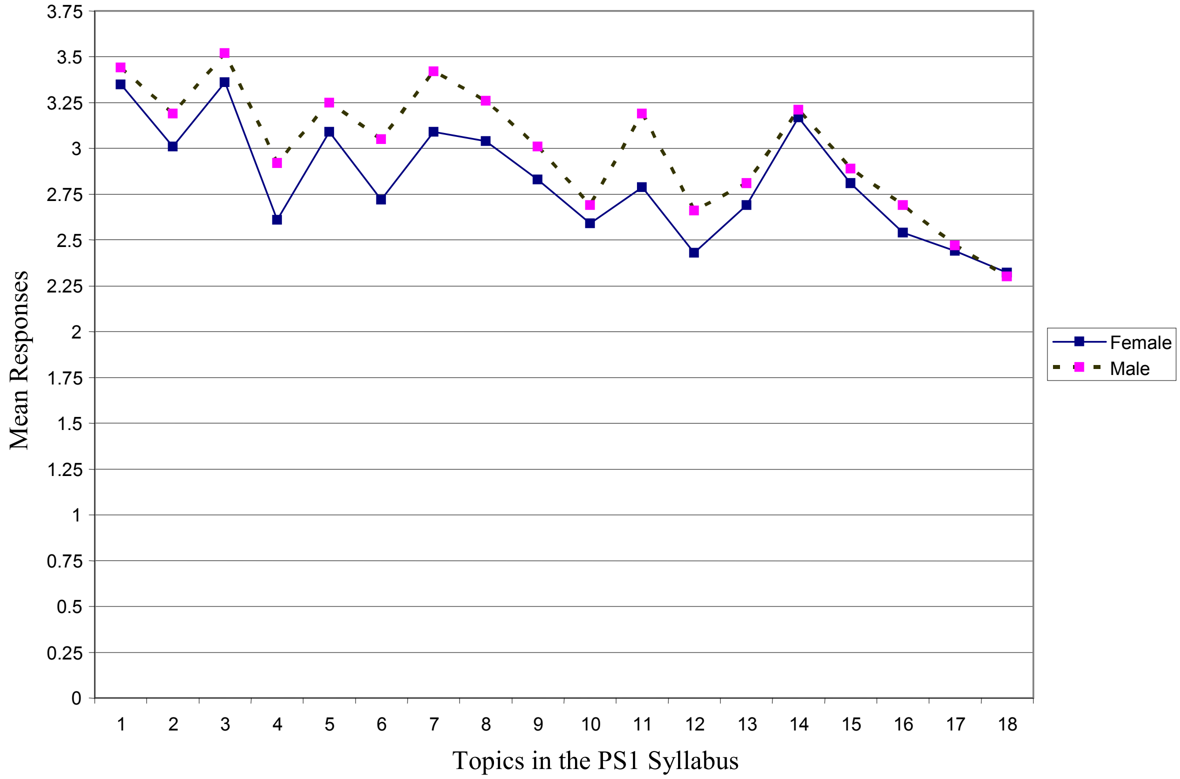

Figure 2 **Mean gender responses on perceived difficulty of topics.**

Discussion

The results have shown that two topics, Measures of central tendency and Conditional Probability and Pascal triangle were not taught by the end of the year. Since these topics are not repeated in the second year syllabus, the pre-service teachers lost the opportunity to learn these topics. This implies that they do not have the knowledge and skills to be able to teach these topics when they graduate from the teacher training college. In addition, they lost the basic foundation upon which other topics are built. For example, knowledge of measures of central tendency is required for a lesson on measures of variation. The pre-service teachers would therefore find it difficult to understand any lesson on measures of variation.

It is not clear why those two topics were not taught. One reason might be that distractions during the academic year did not allow the academic year to run the full course of the required number of weeks. Secondly, it is possible that the demands of the syllabus are more than the current number of hours per week devoted to the subject. Thirdly and more important might be that the tutors themselves did not have a full grasp of these topics so they were not comfortable teaching them. It was therefore not surprising that Probability was

one of the topics the chief mathematics examiner in 1999 noted as a problem area. Teacher training college mathematics tutors need to complete the PS1 mathematics syllabus to afford the students the opportunity to learn and acquire the skills needed to work with.

Out of the 18 topics in the PS1 syllabus, pre-service teachers reported that they found 10 of them difficult. The difficult topics were, Conditional Probability and Pascal triangle, Probability – Compound events and tree diagrams, Movement Geometry, Probability – Experiments and simple events, Circles, Vectors, Measures of central tendency, Relations and Functions, Algebraic Functions, and Geometric constructions. The topics the chief mathematics examiners listed such as number bases, Pythagorean theorem, vectors, and probability are found in the topics the students reported as being difficult to understand.

Since students appeared not to be performing well in the topics they found difficult, it implies in one way that the teachers are not teaching such topics too well. Osafo-Affum (2001) observed that many mathematics teachers 'lecture' instead of 'teach'. Teachers give definitions, make no use of concrete materials and practical ways to explain mathematics concepts. Teachers rather give notes on mathematics just as they would do history. Students tend to verbalize their notes without any meaningful understanding. Fawcett (1970), claimed that some of the teachers of mathematics themselves do not clearly understand certain concepts of mathematics. These teachers in effect rather forced the students to learn the concept through rote method. He quoted some teachers as saying, "when students come to my class, I know what they need and I cram it down their throat". It presupposes therefore that many teachers believe that the 'throat' is the 'highway' for learning mathematics. As a result students parrot what they are taught without necessarily understanding the concepts and ideas they symbolize.

It is suggested that the discovery approach to teaching and learning mathematics be one of the ways of teaching the difficult mathematics topics in the teacher training colleges. Discovery learning could either be incidental or guided. Incidental discovery could almost be described as "accidental" in that it results without much planning or synthesizing of what has happened. In contrast, controlled or guided discovery is planned and there are certain understandings that result from the learning experience. Not only is it planned, but also provides an avenue to extend learning by combining the parts into a more complex whole. It does not mean taking the initiative away from the learner, but that the teacher guides the pupil at a level where he/she is capable of achieving a reasonable amount of success. The students' role in discovery requires and encourages the utilization of as many of his/her senses as possible and at times assuming the principal role in searching for a solution, while at other times the search is a co-operative venture with students planning under the teachers guidance. The teacher initially must plan, develop and arrange an environment conducive to learning and discovery but it is the student who must do the actual discovering of relationships and solutions for himself /herself (Wheeler, Ballenger and Hollis, 1965).

Teaching must be hierarchical. The complex tasks must be divided into subtasks to make the performance of the complex task easy. In teaching the difficult mathematics topics, the student must be taken upwards through a

hierarchy starting from sub-skills which are within the learners' previous competence. At each level the learner puts together two or more of his/her existing skills to achieve the new skill.

It is also important to teach mathematics through various activities linked to other curriculum areas such as Social Studies, Science or Physical education. This because the environment makes an ideal teaching aid much as the nature of activities. This approach would be useful for the teaching of the difficult topics in the PS1 mathematics syllabus. Teachers should link the topics with other subjects such as social studies, integrated science and education. In this way, the students would not treat the topics as on their own but linked to other topics in the teacher training college curriculum and this would provide more opportunities to remember what they were taught in the mathematics class.

Mathematics teachers in the teacher training colleges also need to form an association with the purpose of improving their own knowledge and skills in the teaching of the various topics especially the difficult ones. Another purpose would be to seek ways to improve upon the teaching of mathematics in the teacher training colleges. Workshops and seminars would be helpful in enabling them to acquire more knowledge. The association can also institute the 'Best teacher training mathematics teacher' award as a means of motivating teachers who teach mathematics in the teacher training colleges.

The results of the study have also revealed that differences existed between the Arts-based students and the Science-based students and between the female and the male students in their understanding of topics taught and their perception of the difficulty of the topics. Arts-based students found seven topics more difficult than the Science-based students. The topics were: Relations and Functions, Algebraic Functions, Circles, Movement Geometry, Measures of central tendency, Probability – Experiments and simple events, and Probability – Compound events and tree diagrams. Female students found the following 10 topics more difficult than the male students. The topics were Indices, Number bases, Relations and Functions, Graphs, Algebraic Functions, Solving equations and inequalities, Polygons, Geometrical constructions, Pythagoras theorem, and Movement geometry.

The existence of sub-groups of students who find certain topics more difficult calls for efforts to give more attention to these groups. The Arts-based students as well as the female students should benefit from more tutorials, extra classes and additional assignments in the topics they find more difficult. It is hoped that these efforts would help them to have a greater grasp of the topics. These measures are necessary because of the spiralling effect on the affected groups of students. Since they do not have a good understanding of the topics, they will not be able to teach them effectively when the opportunity to teach arises. This implies that the students who would be taught might also not have a good grasp of the topics. This situation was observed by Grossman et. al. (1992), and Thompson (1992) that how one teaches a subject is influenced greatly by the many ways one understands it. In addition, if these efforts to help the students are not put in place, their performance in the promotion examinations would be affected since the test items cover all the topics in the syllabus.

Conclusion

Mathematics is an important subject at the basic education level in Ghana. Teachers who teach at this level need to have not only the methodological skills but also the content knowledge. It is therefore necessary that the pre-service teachers receive adequate training in the content of the PS1 mathematics syllabus. Teacher training college tutors must attempt to teach all the topics and adopt efficient strategies in teaching those topics that have been identified as difficult. In addition, groups such as Arts-based and female students who find certain topics more difficult need addition care so that their failure to understand certain concepts and topics would not affect the children they would teach when they complete their training and begin their teaching careers.

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Effluent Discharge and Stream Pollution by a Rubber Factory: A case study of Field 20 stream in Odukpani, Cross River State

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Abstract

Increases in socio-economic activities worldwide have been accompanied by a faster growth in pollution stress on especially the aquatic environment. In Nigeria, there are many cases of aquatic pollution that have not been documented. Water quality investigation of Field 20 Stream in Pamol (Nigeria) Limited Estate, Odukpani, Cross River State, was conducted weekly between April and June 2004 spanning a period of 10 weeks. The study revealed that the stream has been heavily polluted by effluents discharge into it. The investigation revealed marked changes between the control point and the downstream station with respect to parameters such as turbidity (from 4+0.7 to 19+ 0.9 F.T.U.) and colour (from 42 + 1.4 to 148 + 1.16 Pt-Co Units), which were above the WHO (1984) permissible limits for inland waters (5.0 F.T.U. and 15.0 Pt-Co Units respectively). Also the variation in dissolved oxygen between the upstream station (5.3+ 0.18 mgl-1) and downstream station (4.4 + 0.08 mgl-1) was below the WHO (1984) limit of>5.0 mgl-1 of dissolved oxygen in water for domestic purposes. Hence the water was considered to have been polluted by the effluents discharged into it. Variations in some other measured parameters between the upstream and the downstream stations though still within the WHO (1984) permissible limits were noticed. The rubber effluents were also analysed and were found to be high in turbidity (68+0.9 F.T.U), low in dissolved oxygen (1.7 + 0.7mgl-1), high again in total hardness (512 +3.2mgl-1), moderate in acidity (6.41+0.6) and very high in colour (510+7.8 Pt-Co Units). Mitigation procedures on the control of the pollution resulting from the rubber factory, for example the decolourization of the highly coloured effluents before the discharge were recommended.

Introduction

The world has entered a period of unprecedented environmental change as evidenced in the rapid growth of natural and man-made changes in the biosphere in recent times. Environmental pollution causing changes in environmental quality is just one issue raising widespread alarm. An increase in socio-economic activities worldwide has been accompanied by an even faster growth in pollution stress, especially on the aquatic environment. This is because the majority of human needs can only be met with goods and services

provided by industries. Industries have the capacity to improve as well as degrade the environment. Raw materials, which have been taken from the natural resource base are converted into products by the industry. Láng (1993) noted that during the production process pollutants are often released into the environment.

Industrial effluents as pollutants contain a large number of both known and unknown substances formed during the production process. Rubber latex processing for example, involves sequential immersion in various chemicals before the final products are ready for the market. This process leaves behind toxic and concentrated aqueous solution with obnoxious odour (Webster and Kwill 1989). The discharge of such mixture may give rise to various types of harmful effects or outright pollution in the receiving environment (Nyholm 1992). The situation is worse where the receiving environment is a water body and the effluents untreated.

Industrial effluents constitute 95% of total waste discharge into the sea (Asuquo 2000). Almost all industries in Nigeria and particularly Cross River State (including the rubber factory of Pamol (Nigeria) Limited discharge their effluents into rivers, streams, estuaries, lagoons or sea. Changes in the quality of rivers, streams, lagoons etc. as a result of industrial activities has been reported in Nigeria (Ajayi and Osibanjo 1981; FEPA 1991; Ntekim *et al* 1993; Asuquo 1999; 2000 etc.). However, the extent to which pollution have occurred in Nigeria hinterland aquatic systems including the Field 20 Stream where rubber effluents are discharge into is yet to be scientifically investigated. Indeed, it is taken for granted in so far as a multinational companies are concerned. This investigation therefore determines the effects of the effluent discharged by Pamol (Nigeria) Limited, Odukpani, Cross River State on the Field 20 Stream that drains the area. Its attendant environmental implications and the pollution abatement measures for mitigating the effect of such effluent discharges in the future are discussed.

Literature Review and Conceptual Framework

Gardener (1977) noted that some of the most serious modifications of streams result from the intentional or unintentional wastes disposal in them. Water quality may be degraded to the extent that pollution becomes obvious and is a major public concern. These modifications, he further noted results primarily from the concentration of people, cities, industries etc. on land adjacent to streams. Hence, the concept of the river basin as a hydrological unit is most applicable here. Under this concept, More (1969) noted that the results of the divers human activities taking place in the river basin are reflected in the river. For instance, water pollutants discharge at one point will flow downstream and adversely affect the water use down the river (or stream)

Jain *et al* (1981) defines pollutions to mean, the impairment of water quality by man's activity causing an actual hazard to public health or impairment of beneficial use of water. Also, the Group of Experts on the Scientific Aspects of Marine Pollution, GESAMP (1988), defines the pollution of aquatic environment to mean, the introduction by man, directly or indirectly, of substances or energy which result in such deleterious effects as (1) harm to living resources (2)

hazard to human health, (3) hindrances to aquatic activities, (4) impairment of water quality with respect to its use and, (5) reduction of amenities.

Some researchers have done water quality studies. Imevbore (1970) noted that some water quality data exist for a number of rivers and lakes in Africa, but are largely confined to the major cations (Na, Ca, K, and Mg) and anions (Cl^- and PO_4^{3-}). Such data are normally collected during surveys of the productivity of the water body concerned or to explain some unusual biological effects. Ajayi and Osibanjo (1981) observed that with the intentions of such studies, data relevant to pollution of the water bodies, such as indices of gross organic pollution (e .g BOD) or levels of toxic micro pollutants (e. g trace heavy metals and trace organic substances) are seldom, if ever, collected. Pollution data on African rivers are therefore very sparse. This situation was first noted by Zoeteman (1973), and there has been little improvement since then (Ajayi and Osibanjo (1981).

Osibanjo (1996) writing on the present water quality status in Nigeria decried a situation where the country is abundantly endowed with freshwater resources with coastal and marine water resources on its southern border located on the Atlantic Ocean has sparsely and un-coordinated water quality data of her fresh and marine waters. That is, the extent and variety of foreign substances in water are sparse and un-coordinated. This is noted as the reason behind the non-existence of Environmental Quality Objective (EQO) and Water Standards in the country.

However, twenty – six (26) Nigerian rivers were sampled during the dry season periods of 1977 and 1978 as reported by Ajayi and Osibanjo (1981). The samples were analysed for biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), pH, dissolved oxygen, ammonia, nitrate and phosphate. Seventeen of the rivers examined were found to be more or less unpolluted, six of them being of high quality and the remaining nine were found to be polluted naturally.

Dauda (1998) gave the summary of results obtained from the analyses of twenty (20) surface water samples collected from some parts of the Federal Capital Territory (FCT), Abuja between 1995 and 1996. In any case, the samples were analysed for the water potability. The results showed that most of the water samples were not polluted. This was possibly due to the low industrial activities and urbanization in the Federal Capital Territory, Abuja.

NEST (1991) noted in a recent study of the effects of the thick black effluent from two breweries in Ikpoba River in Benin City an increase in pH; a decrease in dissolved oxygen; an increase in BOD; a massive increase in COD and an equally massive increase in total suspended solids all of which had adverse effects on the aquatic life. The same team noted that in the 1960s, Rivers Iya Alaro and Shahsa, which drains the Ikeja industrial estate, were used as recreation spots and as sources of water for domestic uses. Today, industrial effluents especially from textile mills, has turned their colour permanently bluish – green. The waters are also characterized by high pH, high level of sodium compound, and a high lead content. These changes, together with substantial heat pollution (the temperature of the effluent is sometimes as high as 50^0C) have made the water unattractive for recreation and definitely unsafe

for domestic use. The vegetation on the edges of the rivers is dying off and there is no trace of fish life for some 3km downstream from the effluent discharge point.

FEPA (1991) published the effects of paper mill effluent on the River Niger and textile wastewater on the affected streams. The effect of the effluent on the River Niger was localized to a short stretch near the river band as reflected visually in the colouration of the water and chemically in increased settleable solid and dissolved solids. The character of the riverbed in the affected area must have been completely altered over the years

In Calabar, different researchers have carried out water quality analysis on different water bodies and water sources for different purposes. Ntekim *et. al.* (1993) reported high levels of heavy metals (Fe^{2+}, Cu^{2+}, Zn^{2+}) in the riverine sediments of the Calabar River. These facts were collaborated by Asuquo (1999) when researching on the physicochemical characteristics and anthropogenic pollution of the surface waters of the Calabar River.. These were attributed to the industrial activities within the area.

Researchers like Esu and Amah (1999) also observed a high level of quality degradation of the coastal waters in Calabar, which they attributed to poor wastes disposal systems, and increase in industrialization especially with the new status of Calabar as a Free Trade Zone in the country.

Moreover, Asuquo (2000) researched on the characteristics of rubber effluents and its impact on the water quality of the upper Calabar River. The investigation revealed marked changes in colour, NH_4 and turbidity which were above the WHO (1984) and FEPA (1989) permissible limits for inland waters. These observations were attributed to effluent discharged into the river from a nearby rubber factory of the Cross River Estates Limited (CREL) in Uyanga. The rubber effluents were characterized by high ionic content (conductivity, $3380 \pm 1285.0\ \mu scm^{-1}$), moderate acidity (pH 5.0 – 6.4) and were totally devoid of dissolved oxygen (zero value). The poor quality of the effluent contributed significantly to the pollution load of the river.

Study Area

Figure 1 is the map of Odukpani L.G.A. showing the Pamol (Nigeria) Limited area of operation and figure 2 is the map of the study area showing sampling locations. The area under investigation is located off km 18 along Calabar-Ikom highway in Cross River State, between latitudes 5^0 05´ N and 5^0 08´ N and longitudes 8^0 18´E and 8^0 22´E, near Calabar, the Cross River State Capital.

A double maxima rainfall averaging 1830mm annually characterizes the area. Most of the original vegetation has been replaced by rubber trees. The detailed geology of the area has been described by Reyment (1965), Murat (1972), etc. to be part of the Niger Delta sedimentary basin. According to Edet (1993), the area has 'good to excellent aquifer rating' and CREBA (1982) gave the transmissivity value as varying between $202.9m^2$/day to $43300.5m^2$/day. The major inhabitants of the area are the employees of Pamol (Nigeria) Limited Company.

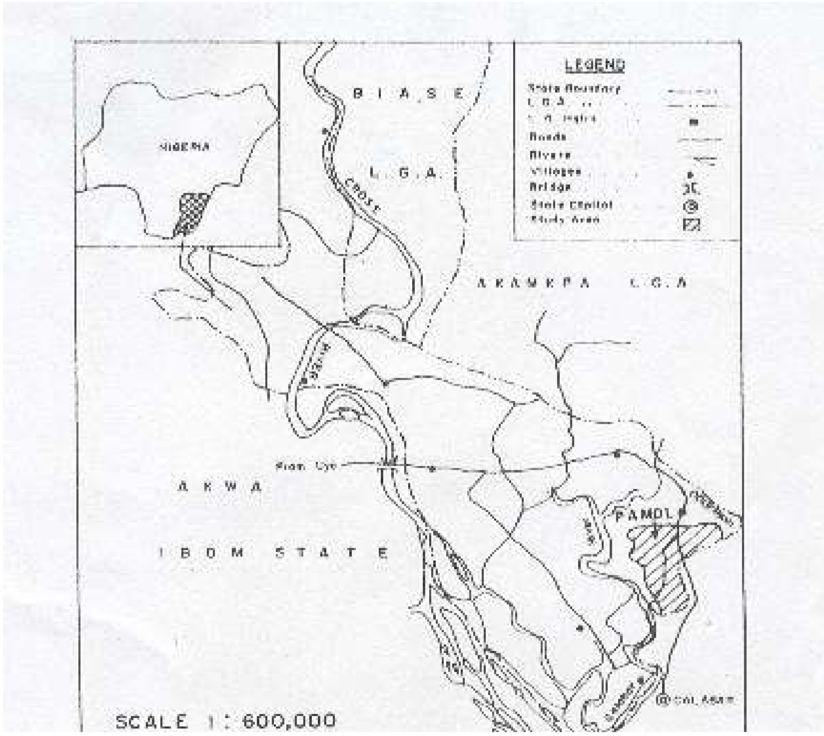


Figure 1 **Map of Odukpani L.G.A. showing the Pamol (Nigeria) LTD area**

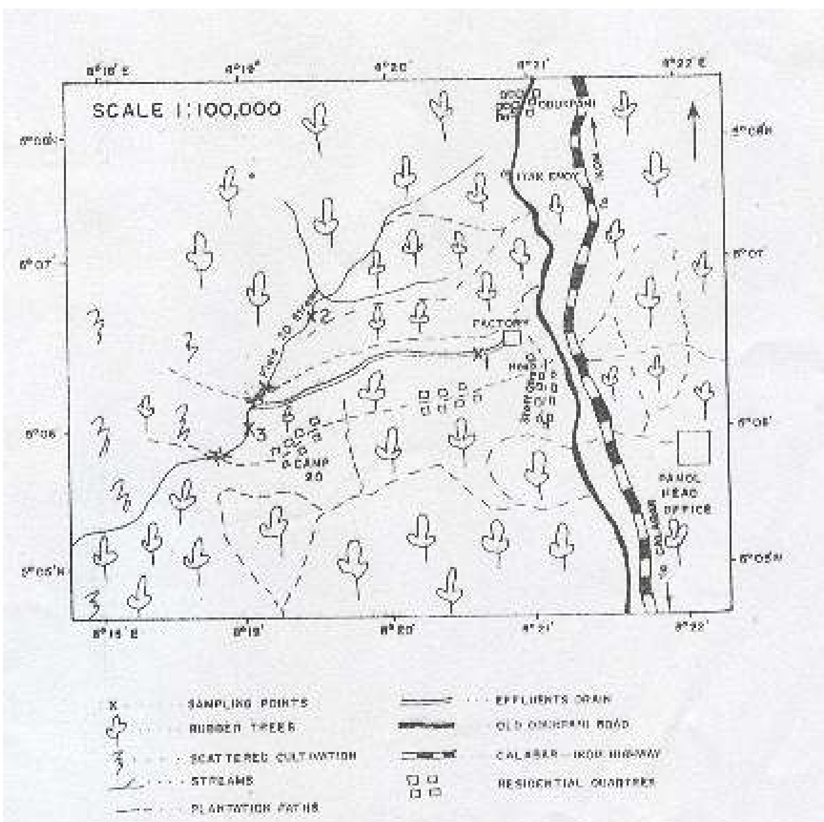


Figure 2 Map of the study area showing sampling locations

Method of Data Collection

Data collection involves the collection of 30 water samples at three (3) different points along the effluent drain and the Field 20 Stream as shown in fig. 2.

The three sampling stations were chosen for this study as follows:

Station 1 Effluent drain, 50m, away from the factory;

Station 2 1000m, upstream of the effluent discharge point;

Station 3 100m downstream of the effluent discharge point. (see Fig 2).

The global positioning system (GPS 12) was used to locate the sampling positions on the globe (See table 1). The "T" model sampling technique (Asuquo 2000) was adopted. The upstream station (Station 2) served as the control based on this model as the stream is unidirectional in the study area.

Eleven (11) water quality parameters were investigated during the study. Five (5) were investigated in-situ. They include temperature and specific conductance which were determined using the HACH conductivity meter, model 44600; potency of hydrogen (pH), using the pH meter, Lutron 201 model; dissolved oxygen (DO) using portable DO meter, model 5509; and turbidity using the secchi disc. The other six (6) water quality parameters: colour, total suspended solids (TSS), total dissolved solids (TDS), total hardness and biochemical oxygen demand (BOD) were determined as described by APHA (1989) and alkalinity, which followed titrimetry with 0.1M hydrochloric (HCl) acid. All laboratory analyses were performed at the Institute of Oceanography, University of Calabar, Nigeria.

Results and Discussion

Table 1 presents the range (minimum and maximum), mean and standard deviation values of the water quality parameters measured at the three (3) sampling stations with the sampling size.

From table 1, dissolved oxygen (DO) in the effluent samples (station 1) was as low as 1.7 $\pm$0.07 mgl^{-1} while those for stations 2 (the control) and 3 (downstream station) were 5.3$\pm$0.18 mgl^{-1} and 4.4$\pm$ 0.08 mgl^{-1} respectively. Dissolved oxygen is used to indicate the degree of pollution by organic matter. (Chapman and Kimstach 1992). The low dissolved oxygen status of the effluent affected the quality of the water downstream hence the reduction of the value of the DO from 5.3$\pm$ 0.18 mgl^{-1} at the control station to 4.4$\pm$ 0.08 mgl^{-1} at the downstream station (Fig 3.1). This value is also below the WHO (1984) minimum permissible limit (>5.0mgl^{-1}) of dissolved oxygen in water for domestic purposes.

The students' "t" test for dissolved oxygen between the control and the downstream station indicated significant differences at both 95 per cent and 90 per cent confidence level between the means of the two data sets (see table 2). Dissolved oxygen is essential to the respiratory metabolism of most aquatic organism. It affects the solubility and availability of nutrients, and therefore the productivity of aquatic ecosystem (Chapman and Kinstach 1992). The

measurement of dissolved oxygen can be used to indicate the degree of pollution by organic matter.

Table 1 Water quality data for the Field 20 stream at the indicated locations.

Parameter	Sampling size	Station 1: Effluent drain 50m away from the factory. GPS: N 05^0 06.387´ E008^0 20.646´		Station 2 (Field 20 Stream): 1000m, upstream of the effluent discharge point. (Control) GPS: N $05^0$06.582´ E $008^0$19.652´		Station 3 (Field 20 Stream): 100m, downstream of the effluent discharge point. GPS: N $05^0$06.081´ E $008^0$19.093´	
		Range	Mean & SD	Range	Mean & SD	Range	Mean & SD
Temperature ^{0}C	10	29.0-2.5	29.2 (0.12)*	29.3-29.5	29.4 (0.07)	29.5-29.7	29.6 (0.07)
Dissolved oxygen DO (mgl^{-1})	10	1.6-1.8	1.7 (0.07)	5.2-5.8	5.3 (0.18)	4.2-4.5	4.4 (0.08)
Turbidity (F.T.U)	10	67-70	68 (0.94)	3-5	4 (0.67)	18-21	19 (0.88)
Total Suspended Solids (TSS) mgl^{-1}	10	48-50	49.2 (0.79)	1-3	2(0.67)	10-12	11 (0.67)
Total dissolved Solid (TDS) mgl^{-1}	10	300-310	307.5 (2.84)	11.6-13.0	12.2 (0.36)	19.0-22.0	20.1 (0.86)
Biochemical oxygen demand (BOD) mgl^{-1}	10	1.4-1.6	1.5 (0.07)	0.4-0.6	0.6 (0.07)	0.7-0.9	0.8 (0.07)
Alkalinity (mgl^{-1})	10	180.0-210.0	199.0 (8.45)	15-25	20.0 (2.36)	15.0-25.0	20.0 (2.36)
Total hardness (mgl^{-1})	10	508.6-517.4	512.8 (3.21)	31.9-32.3	32 (0.12)	110.0-117.3	112.1 (2.13)
Potency of hydrogen (pH Units)	10	6.00-8.21	6.41 (0.64)	6.12-8.30	8.00 (0.63)	7.18-7.80	7.64 (0.18)
Apparent colour (Pt-Co)	10	500-520	510 (7.82)	41-44	42 (1.35)	147-150	148 (1.16)
Conductivity (μScm^{-1})	10	614.2-618.0	615.7 (1.18)	23.8-24.8	24.3 (0.3)	38.2-42	40.5 (1.00)

SD = Standard deviation
*Values in parenthesis are standard deviation

High levels of turbidity increase the total available surface area of solids in suspension upon which bacteria can grow. High turbidity can reduces light penetration and impair photosynthesis of submerged vegetation and algae. This in turn reduces plant growth and may suppress fish production. It also interferes with dis-infection of drinking water and is aesthetically unpleasant (Jain *et al* 1981; Chapman and Kinstach 1992). The result of the investigation shows that turbidity was $68\pm$ 0.94 F.T.U. in the effluent samples against $4\pm$ 0.67 and $19\pm$ 0.88 F.T.U. in the control and downstream samples respectively (Fig. 3.2). The high value of turbidity of the effluents was particularly because of the plastic-like material, resistant to decay released in the processing process. The Student's 't' test also showed significant differences at both 95 per cent and 90 percent confidence level between the means of the two data sets (Table 2).

The value of 19± 0.94 F.T.U. was of course higher than the WHO (1984) 5.0 F.T.U. permissible limits for inland waters.

Table 2: Showing the differences between the calculated t-values and the critical t-values for some measured water quality parameters between the control and the downstream.

Water quality Parameter	Pooled standard deviation	Calculated t-test values	Degree of freedom	Critical t-values* At 95%	At 90%
Dissolved oxygen	0.13	34.6	18	2.10	1.73
Turbidity	0.85	39.22	18	2.10	1.73
BOD	0.065	7.63	18	2.10	1.73
TDS	0.66	26.5	18	2.10	1.73
Colour	1.26	186.9	18	12.0	1.73

* Percentage points of the t-distribution from t-table.

The effect of the colour of the effluent on the stream was very clearly indicated. The effluent with a characteristics colour unit of 510± 7.82 Pt-Co units impacted the water and increased the colour from 42± 1.35 Pt-Co units at the control station to 148± 1.16 Pt- Co units at the downstream station (see also fig. 3.6). The maximum permissible unit of colour is 15Pt- Co units (WHO 1984), even though colour in natural waters could range from 0-300 Pt-Co units (Recourses Inventory Committee 1998). The case of Field 20 Stream in the study area is that of pollution from the effluent discharge by the nearby rubber factory. This is because the upstream sample recorded a value of 42±1.35 Pt-Co, which is also statistically different from that of the downstream (Table 2). Colour in regarded as a pollution problems in terms of aesthetics and increase colour may interfere with the passage of light, thereby impeding photosynthesis.

Potency of hydrogen (pH) ion concentration was 7.64± 0.18 units at the downstream station against 8.0± 0.63 units at the upstream (control station). This variation was attributed to the acidic effluents (6.41±0.64 units) indicating that the rubber factory is a source of organic pollution to the stream. The acidity is contributed by the quantity of the acetic and formic acids applied during acid coagulation of the rubber latex (Asuquo 2000). This acidic effluent could be dangerous to the aquatic community.

Total suspended solids (TSS), total hardness and conductivity were all higher in the downstream samples than in the upstream ones as follows:

TSS was 11± 0.67 mgl^{-1} at the downstream station against 2± 0.67 mgl^{-1} at the upstream station (Fig. 3.3). TDS was 20.1± 0.86 mgl^{-1} at the downstream station against 12.2± 0.36 mgl^{-1} at the upstream station (Fig 3.5). Also total hardness was 112.1± 2.13 mgl^{-1} at the downstream station against 32±0.12 mgl^{-1} at the upstream station (Fig. 3.4), and conductivity was 40.5±1.00 μScm^{-1} at the downstream station against 24.3± 0.3 μScm^{-1} at the upstream station.

FIG: 3.1 Spatial trends in dissolved oxygen (DO) between sampling stations

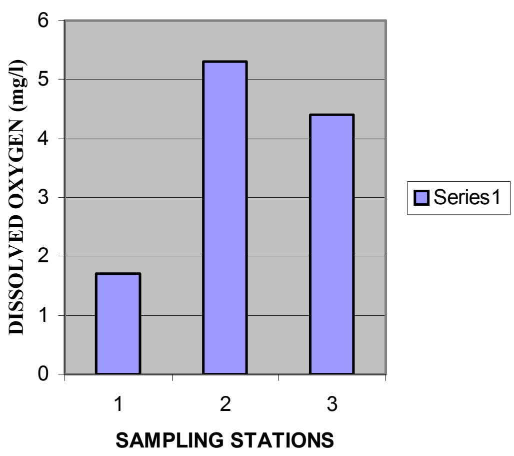


FIG. 3.2: Spatial trends in turbidity between sampling stations

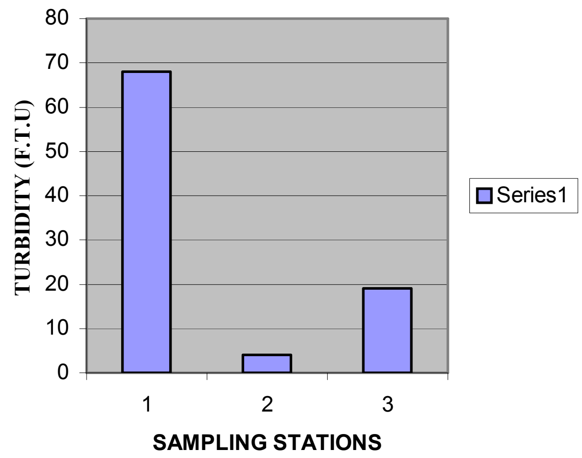


FIG. 3.3: Spatial trends in total suspended solids (TSS) between sampling stations

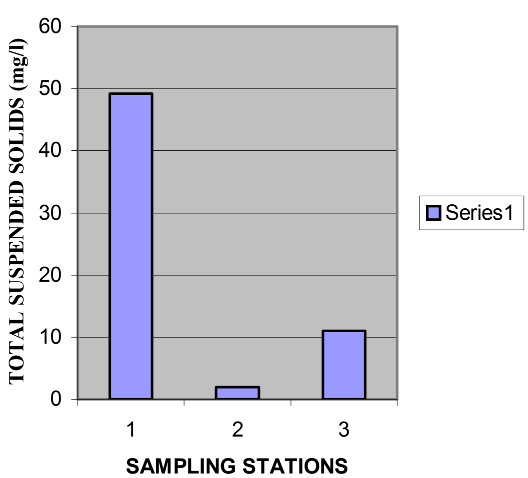


FIG. 3.4: Spatial trends in total hardness between sampling stations

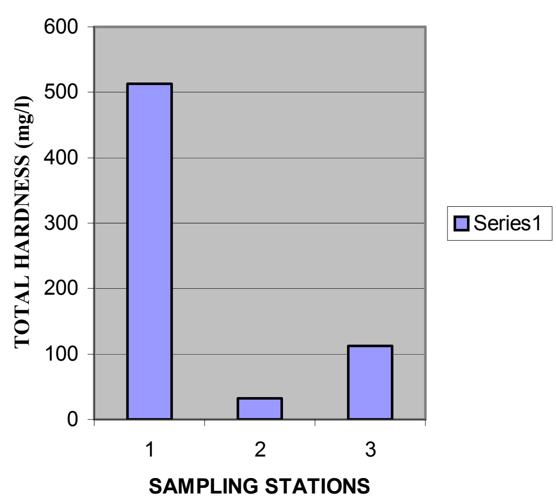


FIG. 3.5: Spatial trends in total dissolved solids (TDS) between sampling stations

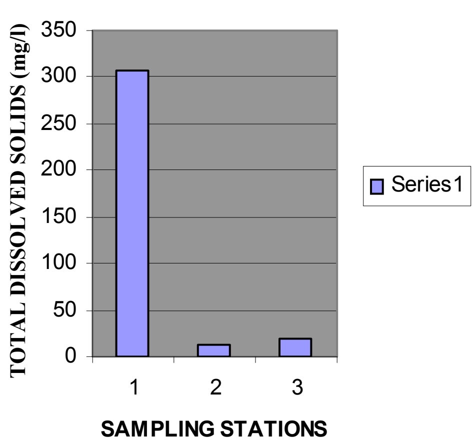
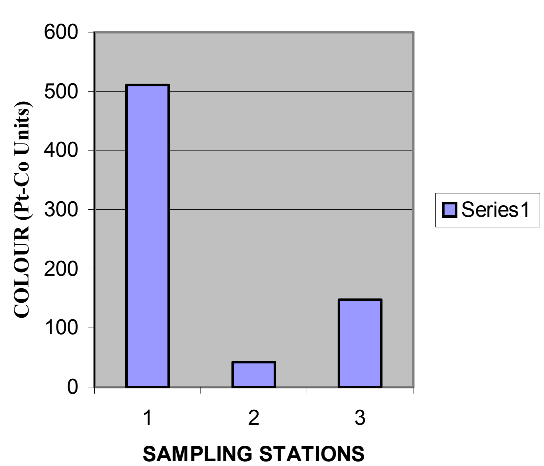


FIG. 3.6: Spatial trends in colour between sampling stations



All these variations were as the result of the reception of effluent discharges with the characteristics of 49.2 $\pm$ 0.79 mgl^{-1} of TSS; 307.5 $\pm$ 2.84 mgl^{-1} of TDS; 512.8$\pm$321 mgl^{-1} of total hardness and 615.7 $\pm$ 1.18 μScm^{-1} of conductivity.

The effluent discharged into the stream also slightly increased the BOD of the water from 0.6$\pm$ 0.07 mgl^{-1} at the control station to 0.8 $\pm$ 0.07 mgl^{-1}.

From the above findings and discussion it was observed that the Field 20 Stream in the Pamol (Nigeria) Limited Estate, Odukpani, Cross River State has been polluted. This pollution is due to the rubber processing effluents discharged into it by the rubber factory.

Conclusion.

This study has revealed that the Field 20 Stream in Pamol (Nigeria) Limited Estate, Odukpani, Cross River State has been polluted by the effluents from the Pamol Rubber Factory. This has greatly affected the use of the water for domestic purposes by the local people. The turbidity was quite high and colourization and the odour unbearable. No doubt the aquatic life forms have been disturbed.

The control of this waste should begin with the decolourization of the highly coloured effluents, which is aesthetically unhealthy, and of great hindrance to biological productivity by aquatic plants. There should be a reduction and recycling of the acid used in the initial treatment process of the rubber latex. There is need (in the interim) to enlighten the people living around the area about the danger of using water from this stream for domestic purposes. There is also need for certification by regulatory agencies of the quality of the effluents discharged by Pamol into this stream. Moreover, there is need for Pamol (Nigeria) Limited to carry out a post-impact assessment of their factory on the project site.

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Population, Deforestation and Biodivlrsity Erosion in the Context of Rural Agricultural Expansion in South Eastern Nigeria

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Abstract

This study attempts to model the relationship between macro demographic factors at the aggregate village level data and the various indices of deforestation arising from rural agricultural expansion. In a multiple regression analysis of five (5) macro demographic (Causative) variables modelled against eleven (11) indices of deforestation (explanatory variables); the demographic factors critical to explaining variations in the various indices of deforestation were delineated. The population size of settlements, farm space density, and the size of households were identified to influence to various degrees, variations in deforestation indictors. The magnitudes of these effects were however, low, evident by low elasticities between population and deforestation variables.

Introduction

Population growth is generally reported in the literature as the major cause of environmental change and degradation (Philip, 1990; McNamara, 1992a; Ajaegbu, 1992a; Davis & Bernstam, 1991). Soil deterioration, deforestation and loss in genetic and species diversity are factors now commonly associated with this phenomenon (Charkeseliani, 1990; Agarwal, 1992). Though the extent to which the population factor accounts for environmental damage has not yet between taken into consideration, few studies however delineate this specific contribution (Bilsborrow & Delargy, 1991; Ajaegbu, 1992b; NEST, 1991; Aina & Salau, 1992; Ologe, *et al* 1992). It is becoming evident in the literature that the population environment relationship cannot readily be cast in a unidirectional fashion (Davis & Bernstam, 1991; Ajaegbu, 1992b), as attempted by McNamara (1992) and justified by Philip (1990).

A complex and multi-dimensional array of factor is now being identified as critical to environmental damage. These factors emanate from the nature of human interaction with the environment (Gourou, 1980; Carrey & Schwartzberg, 1969; Salau, 1992; Salau, 1993). Thus other than relying on the pressures of human population as being solely responsible for environmental change; the size and growth rate of population, the level of technological capabilities, the level of human consumerism, mans social organization and the

way man perceives his environment are presently being identified as the key factors that set the rules, method and rate at which the environment is exploited. (Bisong, 2001). Earlier studies on population and land use change sought to draw links between population densities, intensity of agriculture and food production (Boserup, 1965; Bisong, 2001; Mortimore, 1971; Morgan, 1955). The environmental consequence of the adaptation to population growth and pressure was however given little emphasis.

Later works however began to draw attention to some forms of environmental problems associated with man's interaction with the soils such as population pressure and the subsequent reduction in fallow as it affects soil desiccation, soil erosion and other forms of soil deterioration (Areola, 1990; Okai. 1992). A few studies in recent times have further extended the application of population and land use studies to the conservation needs have forest biodiversity (Myers, 1991; Zaba, 1991). The amount of forest cover available to each individual, a vital measure of forest pressure is estimated to have declined globally by 50% since 1960 to 0.6 hectares per person (Gardner-Outlaw & Engelman, 1999). The observed decline in the ratio of forested land to human beings is attributed to population expansion (Gardner-Outlaw & Engelman, 1999). An emerging viewpoint however holds that although population growth is a factor in natural resource depletion and environmental decline, the question of whether it is the Proximate or fundamental cause still remains to be proved (Global Biodiversity Support Program, 1999). Proponents of this view point holds that the population problem in the context of natural resource and biodiversity decline must be seen beyond the role of absolute numbers and density, and must incorporate other socio-economic variables as mediating between population and environment.

A distinction has therefore been made by some contributors between population and market-based explanations on deforestation (Angelson, 2000; Angelson, Shitindi & Arrestad, 2000). In the context of the study region Lowe (1990) for instance, while reporting that the highest degree of species endemism in biological diversity in Africa occurs in the low land evergreen moist forest of the Cross River State, notes that the over-exploitation of the forest reserves through subsistence farming and cash cropping, hunting for bush meat, and logging activities pose a threat to the survival of these species and the maintenance of genetic diversity. Expanding further on the role of agriculture on deforestation and subsequent biodiversity decline, Philip (1990) maintains that deforestation in the Nigerian context has resulted largely from two processes: the increase in area of subsistence farming as a result of the need to feed a growing population; and the spread of cash crop by peasant farmers to obtain income (McNamara, 1992a).

Cash cropping is observed to have replaced forest cover in the high forest zone with the cultivation of tree crops such as cocoa, cola, oil palm and rubber for exports. The rising prices of foodstuffs have also resulted in the competition of arable crops for forestlands. Vast tract of land in Nigeria has as a result become devoid of forest as could be observed prior to 1970 where forest came to the road edges such as along Benin-Asaba, Obubra, Agoi and Arochukwu, Abakaliki roads. This forest has long disappeared. In Lowe's (1990) viewpoint, pressure on forest can be reduced if the productivity of arable land is enhanced.

A number of other recent studies have called attention to the negative repercussions the loss in biodiversity will have on the prospects of feeding the growing human populations (Ehrlich, Enrlich & Daily, 1993; Ehrlich, Enrlich & Daily, 1993; Spore, 1993; Sattaur, 1991; Sasson, 1990). The common concern in all these studies is the disappearance or erosion of the once diverse range of plant and animal species as they are being replaced by the commercial uniform varieties or modern high yield varieties. The studies are also unanimous about the implication of these trends for social, economic and ecological security for agricultural and ecological systems. Although habitat destruction is identified as the major cause of biodiversity decline and extinction, and the factors of population growth and agricultural expansion are regarded as the major determinants of habitat destruction; the dearth of empirical data to justify these assertions and the poorly understood human and ecological factors within the rural agricultural processes, that serves to exacerbate further habitat destruction and subsequent biodiversity decline/erosion are significant gaps in the literature. This paper therefore seeks to quantify or delineate the effects of macro demographic factors on deforestation in the context of rural agricultural expansion; and to identify the deforestation indicators sensitive to demographic change.

Materials and Method

Study Area

Twelve settlements in the rainforest of Cross River State, South-Eastern Nigeria are the main focus of this study. They fall within the present Local Government Areas of Akamkpa, Ikom and Etung in the Cross River State. These regions are home to the Oban Division of the Cross River National Park and its associated support zones; the Cross River North and South Forest Reserves and the Ukpon, Umon, Oban East and West Reserves, including numerous tracts of Community Protected forest areas (Fig.1) The region occupies a land area of 7908.47km2, or 42.8% of the total land area of the Cross-River State. It lies between latitudes 5”20 and 6”20N and longitudes 8”05 to 8”45E. About 70% of the high forest areas in the Cross River State, South Eastern Nigeria are confined within this zone. The Cross-River State in itself boasts of approximately 31% of the total remaining area of tropical high forest in Nigeria. The total forest Estate area of Cross River State including the Cross River National Park Covers approximately 7,290sq kms (35). The 1991 census estimates the entire population of the study area at 290,548 persons with Akamkpa and Ikom/Etung LGAs placed at 114,924 and 175,624 people respectively. While the overall state population density (crude) can be placed at 101 persons per km^2, the Oban area (Akamkpa LGA) has a significantly lower population density at 22.8 Persons per km^2.

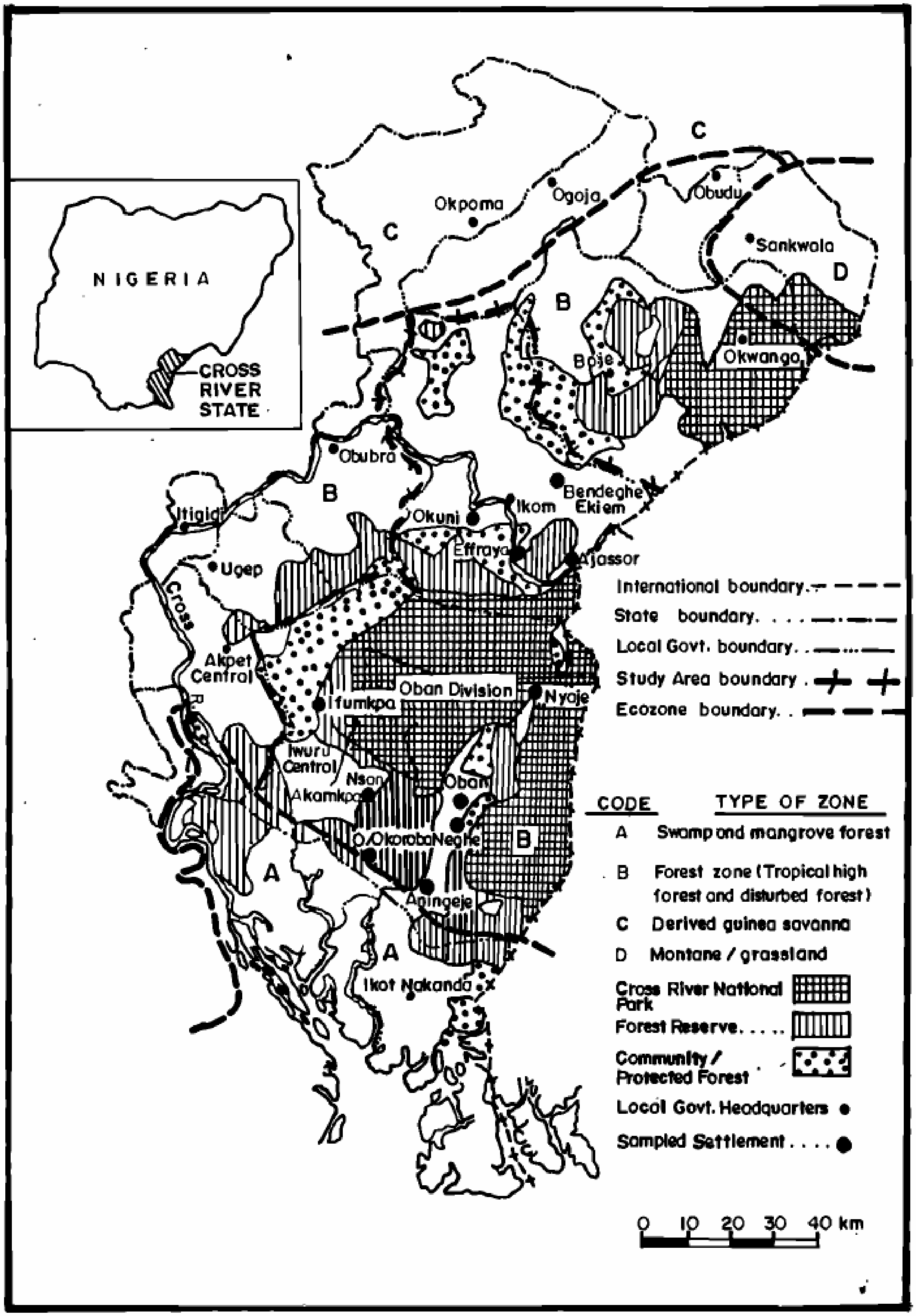

Fig. I : CROSS RIVER STATE SHOWING ECOLOGICAL ZONES, FOREST LAND-USE TYPES AND SAMPLED SETTLEMENTS

The Ikom/Etung areas have a much higher density of 61 persons per km^2. Agricultural land in the region is predominantly used for the cultivation of plantain and banana farms, perennial tree crop farms, homestead trees and gardens; and other staples such as cassava, cocoyam, maize, yam, melon, etc. (36, 37). Bush fallow cultivation is clearly dominant as it engages about 84% of the population.

Method

The study employed the use of questionnaire administered to 864 households in twelve (12) sampled settlements. The settlements were purposively selected based on their proximity to the different forest categories, but stratified to reflect the large, medium and low settlements with respect to their population sizes. The number and proportion of sampled households in each of the settlements are shown in Table 1.

The specific data collected were the demographic and socio- economic characteristics of the population, such is, the size of household dependency levels, population size of settlements and agricultural density. Data on land and forest use characteristics were also collected such as cropping and fallow patterns, average number and size of farm plot average size and frequency of forest clearings, and levels of floral and annual species extinction. With the use of aerial photographs, the size of deforested areas around each settlement was estimated. The multiple regression analysis was used to model the impact of demographic variables on deforestation indicators arising from agricultural causes.

Results and Discussion

An attempt is made quantify the effects of some selected macro demographic factors (for aggregate village level data) like average household size, dependency ratio, population size and farm space density on indices of deforestation such as crop area, crop/fallow area, total deforested area, flora and fauna species extinction etc. It is aimed at identifying the critical macro demographic variables responsible for deforestation and the extent and magnitude of their impact. In Table 2 is data used for the analysis.

Table 1: Sampled Settlement And Attributes Of The Study Area

S/n	Settlements	Population size 1993	Estimated Number of Households	Number of Sampled Households	Percentage of Sampled Households to total number Estimated Households	Locational Characteristics Of Settlements by Forest Category
1	Bendeghe Ekiem (BE)	8278	1067	150	14	Community Forest
2	Effraya (EF)	1387	133	50	37	Forest Reserve (Cross River North)
3	Okuni (OK)	5418	584	99	17	Distant Forest Reserve (Cross River South/Community Forest
4	Ajassor (AJ)	5556	410	100	24	Forest Reserve (Cross River North/community Forest
5	Nsan (NS)	2365	211	50	24	Forest Reserve /National Park
6	Oban Okoroba (OO)	378	21	18	86	Enclave in Forest Reserve (Oban west)
7	Iwuru (IW)	1417	151	47	31	Community Forest
8	Ifumkpa (IF)	671	70	50	71	Large Community Forest/National Park/Forest Reserve
9	Oban (OB)	3474	357	78	22	Community Forest/ National Park/ Forest Reserve
10	Neghe (NJ)	590	70	38	54	Community Forest/ National park
11	Nyaje (NJ)	1750	243	63	26	Community Forest/National Park
12	Anningeje (AN)	6710	902	121	11	Forest reserve/ Small community forest
13	Total	37994	4038	864	21	

The regression model is given by the equation:

$$\mathbf{Y = do + a_1x_1 = a_2\ x_2 + a_3\ x_3 + an_4\ xn_4 + a_n\ x_n + e}$$

Where: y = the dependent variable

Xi = the ith independent variable, i = 1, 2, 3 ¡¡±

Ai = the regression parameter (coefficient) associated with the variable I,

E = the stochastic error term with the usual properties.

TABLE 2: SELECTED DEMOGRAPHIC VARIABLES AND DEFORESTATION IN THE CROSS RIVER RAINFOREST

Settlement	Row	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
IKOM CHARGE																	
Bendeghe Ekiem (BE)	1	7.76	31.85	51.85	8278	147.69	26.09	56.05	56.30	0.0068	16	16	9.40	27.72	7.016	3.15	56.30
Efraya (EF)	2	10.44	51.61	91.84	1387	31.37	19.17	44.21	54.18	0.0390	10	13	7.22	18.04	5.830	1.56	46.06
Okuni (OK)	3	9.28	56.88	122.00	5418	88.92	33.45	60.93	61.15	0.0110	8	8	7.74	30.56	5.830	3.19	60.93
Ajassor (AJ)	4	13.55	62.25	107.46	5556	189.04	10.73	29.39	32.79	0.0059	9	9	8.64	68.07	8.740	3.08	29.80
AKAMKPA CHARGE																	
Nsan (NS)	5	11.22	68.75	120.41	2365	70.51	24.61	33.54	69.15	0.0290	5	10	3.70	6.86	5.250	0.44	33.57
Oban Okoroba (OO)	6	9.00	67.77	122.00	378	204.32	0.38	1.85	2.18	0.0058	1	8	6.28	13.17	4.060	0.44	2.18
Iwuru (IW)	7	9.10	90.78	154.00	1417	30.42	26.38	46.58	46.58	0.0330	6	13	7.30	22.57	6.030	3.67	46.30
Ifumkpa (IF)	8	9.52	104.63	196.44	671	58.81	2.28	11.41	11.46	0.0170	5	8	3.08	8.10	3.640	4.15	11.46
OBAN CHARGE																	
Oban (OB)	9	9.73	64.44	120.00	3474	65.33	47.37	53.18	13.86	0.0220	12	31	7.71	27.21	3.560	1.79	53.77
Neghe (NE)	10	8.45	77.77	137.00	590	62.83	4.45	9.39	9.67	0.0160	24	24	4.89	10.13	3.710	1.68	9.67
Nyaje (NJ)	11	7.21	64.18	105.57	1750	184.41	3.79	9.24	9.58	0.0055	8	19	12.63	24.63	4.700	3.79	9.47
Aningeje (AN)	12	7.44	88.24	179.91	6710	197.75	32.75	37.33	55.95	0.0083	16	34	7.02	11.90	8.640	2.61	40.00

SOURCE: Author's Field Data, 1994

The variables reflected on the table are defined as follows:

C1 = Average Household size

C2 = Dependency ration (0-14yrs) + 65 yrs

C3 = Dependency ration (0-19yrs) + 65 yrs

C4 = Population size

C5 = Farm space density

C6 = Cropping area (sq km)

C7 = Crop/fallow area (sq km)

C8 = Total deforested area (sq km)

C9 = Deforestation ratio

C10=Animal species extinction

C11=Flora species extinction

C12 =Average no. Of plots per person

C13 =Average plot size per person

C14 =Average size of recorded clearing

C15 =Average frequency of forest clearing

C16 =Deforested area net of government plantations.

The independent variables used in the regression analysis are average household size (C1), dependency ration 1-14 yrs. (C2), dependency ration 0-19yrs (03), population size (C4), farm space density (C5). The dependent variables are C6 to Cl6 as defined above. In the actual regression runs, C2 and C3 were found to be highly collinear. They returned a correlation coefficient of 0.967. This suggests that both cannot be used as independent variables in the same egression equation due to the factor of multi-collinearity. The actual regression analysis thus employs only four independent variables (C1, C2, C4 and C5) against eleven dependent variables (C6 to C16). The regression results are presented in Table 3. In the regression between crop area (C6) on four independent variables C1, C2, C3, C4 and C5 three of the variables C2 (dependency ration), C4 (population size) and C5 (farm space density) were statistically significant with very low P-values. The P-values are reported in brackets below the parameter estimates they correspond. Population size (C4) for instance has a P-value of 0.031 which implies that population size is statistically significant at 3.1 percent level.

The four variables C1, C2, C4 and C5 together accounted for about 59 percent of the total variation in C6 (crop area). In the case of the dependent variable C7 (crop/fallow area), the size of household (C1) and the dependency ratio (C2) were not statistically significant in explaining its total variation; whereas C4 (population size) and C5 (farm space density) were statistically significant in explaining the variation in C7. The four variables taken together accounted for 84 percent of total variation in C7. With respect to C8 (total deforested area) and C16 (deforested area net government plantations), only two variables C4 (population size) and C5 (farm space density) were found to be statistically significant in explaining changes in deforestation as reflected in variables C8 and C16. The four variable (C1, C2, C4, and C5) jointly accounts for 68 percent of total variation in C8 and 73 percent of variation in C16.

Table 3 Multiple regressional analysis of macro-demographic factors and deforestation

The Regressional Equation: Cj= Aj + A1*C1 + A2*C2 + A3*C4 + A4*C5
(j = 6, 7,… 16)

Row	C1	C2	C4	C5	R2	Crit
C6	-0.599	0.029	0.004	-0.131	59	C2, C4, C5
	(0.785)	(0.031)	(0.031)	(0.063)		
C7	0.100	-0.176	0.006	-0.211	84	C4, C5
	(0.959)	(0.369)	(0.01)	(0.004)		
C8	1.65	-0.133	0.007	-0.24	68	C4, C5
	(0.62)	(0.74)	(0.02)	(0.032)		
C9	0.0009	-0.00004	-0.0000006	-0.00013	76	C5
	(0.48)	(0.76)	(0.576)	(0.032)		
C10	-1.286	-0.008	0.0010	-0.03	28	None
	(0.303)	(0.946)	(.318)	(0.43)		
C11	-2.400	-0.115	0.0013	-0.0107	33	None
	(0.186)	(0.513)	(0.356)	(0.824)		
C12	-0.350	-0.064	-0.00001	-0.013	47	None
	(0.428)	(0.174)	(0.972)	(0.295)		
C13	5.75	-0.133	0.0019	0.067	43	C1
	(0.034)	(0.57	(0.309)	(0.312)		
C14	0.316	0.020	0.0005	0.006	51	C4
	(0.196)	(0.406)	(0.02)	(0.388)		
C15	-0.137	0.012	-0.000005	0.0064	0	None
	(0.530)	(0.570	(0.970)	(0.315)		
C16	0.08	0.19	0.006	-0.213	73	C4, C5
	(0.907)	(0.35)	(0.003	(0.005)		

Notes: The Value in Brackets are the P-Values

For variable C9 (deforestation ratio) which expresses the ratio of total deforestation area to the population size of settlements, only one of the four independent variable (C5) was statistically significant in explaining it at 3.2 percent level. All the four independent variables however jointly accounted for 76 percent of the total variation in C9 (deforestation ratio). None of the four independent variable (C1, C2, C4, C5) were statistically significant in explaining the variations in variable C10 (Animal Species extinction), C11 (floral species extinction), C12 (average no. Of farm plots per person) and C5 (average frequency score of forest clearing). Although the joint contribution of all variables accounted for 28%, 32% and 47% respectively in explaining variations in C10, C11 and 012.

Average size of household (C1) was interestingly found to be the only variable among the four independent variable as that was statistically significant in

explaining the variations in C13 (the average plot size per person). The interesting aspect of the result is that household size had hitherto never showed up as being statistically relevant in explaining the variations in any of the dependent variables but only significant in relation to the size of farm plots. The result confirms earlier analysis of micro- demographic variables when household size was statistically significant in explaining the variations in forest resource use variable particularly that of size of farm plot (38). At the macro level analysis, it has shown up again as a critical factor (the only critical factor) in explaining variations in average size of farm plots per person (C13). It is critical at a 3.4 percent level i.e. about 97% confidence level and accounts for 43% of the total variation in average plot size per person. With respect to the average size of recorded clearing for survey area (C14), only population size (C4) among the four independent variables were critical in explaining its variation at 2 percent level. The combined impact of the four variables jointly accounts for 51 percent of the total variation in C14. Given the fact that multiple regression deals with the joint contribution of the independent variables on the dependent variable, it was average size of household (C1) was interestingly found to be the only variable among the four independent variables that was statistically significant in explaining the variations in C13, the average plot size per person).

The interesting aspect of the result is that household size had hitherto never showed up as being statistically relevant in explaining the variations in any of the dependent variables but only significant in relation to the size of farm plots. The result confirms earlier analysis of micro-demographic variables when household size was statistically significant in explaining the variations in forest resource use variable particularly that of size of farm plot (38). At the macro level analysis, it has shown up again as a critical factor (the only critical factor) in explaining variations in average size of farm plots per person (013). It is critical at a 3.4 percent level i.e. about 97% confidence level and accounts for 43% of the total variation in average plot size per person. With respect to the average size of recorded clearing for survey area (C14), only population size (C4) among the four independent variables were critical in explaining its variation at 2 percent level. The combined impact of the four variables jointly accounts for 51 percent of the total variation in C14.

Given the fact that multiple regression deals with the joint contribution of the independent variables on the dependent variable, it was thought necessary to investigate further the contributions of each of the important independent variables on the various deforestation indices. The results are reported in Table 4. A profile of the result indicates that the dominant factor in deforestation is population size. It was statistically significant at whatever index of deforestation used. This was closely followed by farm space density. Both factors together accounted for 77.6% of the variation in deforestation indices such as the expansion of crop/fallow area, 48.6% variation in crop area, 58.5% variation in total deforested area, 67.1% variation in deforestation ratio and 48% of variation in the average size of clearing. They are all statistically significant in explaining the above stated variations at over 95% confidence level or less than 5% level of significance. Population size alone explains 23% of the total variation in deforested area, 33.7% of variation in deforested area net government plantations, 22% of variation in crop area, 35% for crop/fallow area variations and 51% of variation in average area of recorded clearing for survey

year. The above relationships are shown in Figures 2.to 2.4 representing the scatter plot with their respective lines up best fit.

Table 4 **Regressional Analysis Of Macro-Demographic Factors And Deforestation (Parameter Estimates Of The Regression Equation)**

Regression Model: Cj = A1 + A2*C2 + A3*C3 + A4*C4 (j = 6, 7, …… 16)						
	C2	**C3**	**C4**	**C5**	**R^2**	**Critical Factors**
C6	0.034 (0.871)		0.0045 (0.021)	-0.129 (0.05)	42.4	C4, C5
C6		0.033 (0.733)	0.0045 (0.015)	0.129 (0.047)	43.1	C4, C5
C6	-0.177 (0.47)				0.0	
C6			0.003 (0.068)		22.4	C4
C6				-0.058 (0.105)	0.0	
C6			0.0044 (0.009)	-0.128 (0.36)	48.6	
C6	0.0334 (0.895)		0.0032 (0.112)		13.9	
C7			0.007 (0.00)	-0.211 (0.00)	77.6	C4, C5
C7			0.0049 (0.026)		34.6	C4
C7				-0.093 (0.38)	1.6	
C8			0.0052 (0.065)	-0.122 (0.013)	231.4	C4
C8			0.0079 (0.004)	-0.249 (0.13)	58.5	C4, C5
C9				-0.0015 (0.0)	69.5	C5
C9			-0.0009 (0.164)	-0.0014 (0.002)	10.3	
C9			-0.0 (0.618)	-0.0014 (0.002)	67.1	C4, C5
C9			-0.0	-0.0014 (0.002)	67.1	C5
C16			0.0049 (0.028)		33.7	C4
C16			-0.099 (0.301)	-0.099 (0.301)	1.7	
C13	$5.211C_1$ (0.062)				23.8	C1
C14			0.005 (0.006)		50.9	C4
C14			0.00046 (0.019)	0.0042 (0.525)	48.0	C4, C5
C16			0.000489 (0.028)		39.7	C4

No other demographic variable singularly recorded such feats among the macro-demographic factors in explaining the pattern of deforestation. The size of household is however critical in explaining the pattern of resource use where the natural resource use variable in question is the average size of farm plots per person. It explained 2&8% of the total variation in average per person plots size.

This relationship is visually represented in figure 2.5. Farm space density expressed as the number of persons per unit of agricultural land is the next most critical variable to population size in explaining the deforestation phenomena. This variable however has no statistically significant effect on deforestation when acting alone. It yielded a rather insignificant level of explanation (1.4%) with respect to the total variation in deforestation. Population size when acting alone exerts a positive impact on deforestation and accounts for 25% of total variation in deforestation area as earlier observed. Its impact on deforestation increases in concert with farm space density. We may therefore conclude that population size reinforces the effect of farm space density on deforestation and vice versa. They together account for 58.5% of total variation in deforestation area. The same pattern can be observed on the impact of population size and Farm space density on such indices of deforestation like crop area (C6) and crop/fallow area (C7). For instance the joint action of population size and farm space density account for 77.6% of total variation in the crop/fallow area (C7). Acting independently of each other, population size and farm space density accounted for 34.6% and 168% respectively of the total variation in the Crop/fallow area.

Summary and conclusion.

Population size and density are the most critical of the demographic variables at aggregate village level data that impacts positively on the various indices of deforestation. Farm space density however, had no significant statistical impact on most indices of deforestation except in conjunction with the population size of the settlements. The size of household was found to be critical only in explaining variation in the average size of farm plots, but yielded no such significance in explaining the variation in deforestation indicators. The above in a measure validates the research hypothesis that deforestation and forest resource use pattern; of communities in the Cross River State Rainforest, South-eastern Nigeria, is related to the micro and macro level demographic factory such as the size of households, the population size of settlements, firm space or agricultural density, and the dependency burden of the rural households. The magnitudes of their effects are however low due to the very poor elastic ties between population and deforestation variables.

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